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THE GEOGRAPHICAL SITUATION OF THE UNITED STATES IN RELATION TO WORLD POLICIES

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IT IS ESPECIALLY gratifying to come to London at a time when our two countries are deeply engaged in a common search for peace through bold and novel forms of reconstruction and reorientation. In that search all cultural agencies, and especially our geographical societies, may hope to play a useful part. In addressing you to-night I can only touch upon a few of the many geographical aspects of that vast canvas known as international politics. Acting as I did in the period 1942–45 as special adviser to two Secretaries of State, I ought to make clear at the beginning of my paper that the views expressed therein are wholly personal and that I have sought neither review nor endorsement by an officer of the government of the United States.

On the higher levels of strategy and statesmanship, two critical themes emerge that bear directly upon our well-being and survival. For what high ends we use power is one centre of effort, and how we make use of geography is the other. These enduring conditions of moral strategy, as one may call it, are well illustrated in some of the publications of the Royal Geographical Society in London and its sister institution, the American Geographical Society of New York, and in their unique services to their respective governments during two world wars. Like the United Kingdom and certain members of the British Commonwealth of Nations, America has undertaken to share responsibility within the wide circle of the United Nations. The grand principle that permeates the Charter of the United Nations is that agreements respecting the solution of international problems shall be reached and executed on the basis of collective opinion determined by majority vote. For reasons only too well known, the application of that principle has been tragically delayed by the breaching of an interpretation, agreed to by the Great Powers at San Francisco, that the restricted and special device of the veto would be used but rarely. In consequence, the fear of war again overshadows the world. It is natural, therefore, that men should return to the idea of a balance of power, once so roundly denounced, and look closely at the world in terms of economic and military advantages.

In the effort to attain a balance of forces in world politics two disturbing questions arise. First, is such a balance possible? And second, can a balance or equilibrium be attained by international agreement? A biologist suggests that nature abhors an equilibrium. We should not dismiss as mere analogy this interesting idea when applied to human organization and effort. For example, the tendency toward disequilibrium is the root of the difficulty in devising any scheme of power control in the United Nations. As geological exploration and scientific discovery proceed, and new resources of astounding potential are discovered, power disequilibrium comes into play concurrently. The present feverish search for sources of uranium cannot end in a nice balance of access and use. With vast oil deposits, two otherwise weak countries, Saudi Arabia and Venezuela, suddenly rank high in the power field. It is often said that geography does not change. In truth geography changes as rapidly as ideas and technologies change; that is, the *meaning* of geographical conditions changes. No first-class power can overlook the new geographical significances that come to light daily as the great international experiment proceeds. Every major technical and power development must be followed by a resurvey of world geography, region by region and indeed point by point.

The fleeting condition known as balance of power can be elevated to dangerous heights in national thought and come to be accepted as a dominant "principle," with resulting waste of vital resources. It is really an unattainable goal. Instead of fixing our hopes on so unreal but comfortable and reassuring an objective, it would be better to accept the idea that nature, including human nature, abhors an equilibrium. The forces of life are not equally nourished over the wide earth. The differences in birth rates and population structures country by country are a case in point. The basis of a numerical voting scheme in a world assembly for to-day is destroyed tomorrow by rapidly changing rates or amounts of population growth.

Ideas are even more potent in their unbalancing effect than continuing discoveries of resources. Strive as they may for a balance of power, the nations of the world cannot agree upon a mode of attaining it. To-day the clash of social ideas behind the effort keeps the whole world structure in unbalance. It is the great merit of the United Nations that it attempts, not the unattainable but an attainable goal. It is a way of reaching *working agreements*, not an agreement to attain a balance of power. Geography, like history and politics, is a discipline by which we can better understand "power," that vast network of changing forces that both enclose and condition two groups of human societies that are now contending on a world scale with fateful consequences. If we are wise we shall focus our attention on the unending process of readjustment among the many, rather than on a temporary condition of balance among the few. The process of adjustment of men's claims and rights must be as continuous as life itself. Confronted by the eternal difficulties of world politics, minds that wish to escape from reality prefer an heroic solution, hence the popularity and appeal of "world government" and peace by force. Heroic solutions solve few problems and always create a crop of new ones, for all rest essentially on force without prior agreement on how to use it in unpredictable circumstances.

Power is not a matter of resources only. National confidence is a single,

often neglected, psychological factor among many. When a distinctive cultural group gains a place of acknowledged power it becomes self-confident, indeed too confident for the comfort of its neighbours. The makers of its political theories and structure are likely to think that they have found the key to permanent success. Conceit leads them to assert that they have solved at last the complex art of governing men. The Soviet Union now has vast territory and resources, a vigorous people and, to weak or frustrated souls, a bewitching theory. The confidence of Soviet leaders, after enjoying thirty years of power unqualified by a free and popular referendum, enhances our present danger. In the United States we know the mood of confidence. We know how easily it acquires a mystic quality. Not long ago the American phrase for it was "manifest destiny." Both Russia's "urge to the sea" and America's urge to the Pacific are old stories; now for both peoples come the consequences. They meet in the East as in the West; two totally unlike stocks with different historical and cultural backgrounds, Slav on the one hand, and on the other that mixture known as American with basically Anglo-Saxon institutions.

The self-dependence of the American pioneer entailed political independence; and the impulse and opportunity of growth and the sense of destiny stimulated a spread of population and sovereignty that spanned a broad and richly diversified continent from sea to sea. America at all stages had the feeling of great days ahead. The rapid expansion of a culture eventually so well equipped technologically did indeed create a sense of destiny and of providential success which was carried over into easy assurance about the good life and its attainability by all mankind. Woodrow Wilson, a powerful advocate of American political ideals, frequently employed the phrase "all men everywhere" as if the diverse peoples of sixty nations in their widely different environments and unequal stages of cultural and political advancement (or retrogression) were all waiting eagerly to receive the demonstrated blessings of Jeffersonian democracy.

America was fortunate in the inheritance of political ideals and theories that kept its national compass needle fairly steady. Whatever the deviations, American political leaders did obtain true bearings by which to correct the national course. Our constitution and legal system, our adherence to the World Court, our Good Neighbour Policy, our willingness twice in a quarter of a century to stand, however tardily, beside the democracies of Western Europe, were neither materialist nor imperial in origin. They reflected a deep conviction about values, and if it was a slow-grown conviction it was also deliberate, and therein lies its chief assurance. If isolationism did not die at Pearl Harbour, the virtual destruction of our Pacific Fleet at least permanently disabled this mistaken policy. Our economy, the so-called "American system," believed to be impregnable in the 1920's, took a plunge in the 30's—a humiliating experience. It was the final cure for our century and a half of over-confidence. We learned that pulsing, unpredictable life is above system, that our defence and our destiny alike grow out of wide comprehension and virility joined to ideals and sophistication, and that without these our vaunted "system" will in time be one with Nineveh and Tyre.

The economic crash of 1929 ended the era of over-confidence. The long

train of dismal consequences, world-wide in scope, taught us that we had to be sensitive to the realities of the whole globe if our American system was to have any meaning or stability. There is no doubt that the depression contributed to that new cycle of power politics and dictatorship in which we became rapidly involved. In the end we were compelled to remove our rose-coloured spectacles as we looked at the geographical stage and historical background of other men's dreams as well as our own. It was no longer enough to recognize an advantage here or a disadvantage there; not Greenland only, or Guam or the Panama Canal had become important but also the northernmost stretches of Alaska, the vulnerability of the Amazon, the happenings in Outer Mongolia and Sinkiang, and the forces that contend along the 38th parallel in Korea. Whatever the inconsistencies and vagaries of current politics, the United Nations is now a definite part of the American system and ideal. In this we occupy no unique position. Such is the theory and intent of the Charter that, in a sense, the territorial base of every sovereign state that signed it is now the world.

On the instant of Pearl Harbour we had to think in global terms and we were nationally unprepared for such thinking. Perhaps 95 per cent. of our people "finish" geography in the seventh grade of elementary school. As in England before the era of Mackinder and his professional contemporaries, we were "parochial" in thought, to use Lord Morley's term for British thinking in 1910. Distant countries were words and pictures in a book, not land and field and culture systems and irreducible human diversities. They were strange and far away, of no significance to the United States except as sources of trade or as fields of Christian missionary endeavour. To-day it is universally recognized that geographical realities play a significant rôle in major cultural advances and also in that slow-growing process that holds the most substantial promise for human dignity and freedom, namely, the consolidation of power in countries outside the orbit of Soviet Russia.

America has confidence still but it is a new and higher confidence based upon deep conviction, upon tested foundations and, however we may regret to include it, upon material power and the national will to use it when confronted by acts of aggression collectively defined. To my mind nothing symbolizes the contrast between the Soviet and the non-Soviet world so sharply as the different conceptions they hold respecting the use of power. To-day the choice is clearly presented between the contrasting values and systems of Eastern and Western Europe, and the contrasting ends towards which they direct their policies and powers. For America the choice is clear because our object is liberty. Turn liberty any way you please, and acknowledge the too-frequent betrayal and corruption of some of its advocates, yet peoples provided with an opportunity to do so move instinctively towards it.

In the renewed world struggle between freedom and the arbitrary use of power, we cannot risk public misunderstanding of the foundation of our faith in democratic institutions. The free flow of criticism and a high degree of self-criticism supply the indispensable conditions of flexibility and experimentation that keep men productively hopeful and willingly united. The contrast between democratic flexibility and the brittle structures reared by force and arbitrary command was never better demonstrated than in the

period 1933 to 1945. Again we see the contrast taking shape in the divided world of to-day. Again we see the fundamental error emerging, an error that I would state as follows: if a spontaneous human organization exists, arbitrary power, whether secret police or military, assumes the right to command it, and *when arbitrary power assumes command it begins by depreciating and ends by despising the men it commands.*

Domestic resources of the United States

The industrial output of the United States during the recent war and the scale of its present exports of food, seed, machines and credit may be misunderstood unless public education on the limits of aid becomes as substantial as the aid itself. The huge scale of the world's need and the sure depletion of our strength if aid on the present scale is too long continued are sources of anxiety to the American people, and their government has recently given vigorous expression to such anxiety. In the United States we are now, as a result of supplying war needs and our own domestic requirements, for the first time cutting our forests at a rate that exceeds natural growth. We are therefore deeply concerned in the world survey of forestry resources that the United Nations Economic and Social Council intends to make.

The phenomenal agricultural production of the United States to-day may help solve immediate political difficulties abroad but it also raises a crop of tares that will come to harvest one day soon. Given a few years of agricultural recovery in the world—in Europe principally—and we shall have to step down American production at a pace that will confront our national economists with a problem of price adjustment, and perhaps of price control, whose solution will have severe effects throughout all parts of our economy. Yet if the opposite course be pursued and agricultural production for export be continued, the effect will be no less momentous for we are exhausting our soils in the process. The hungry world should appreciate our dilemma.

The narrowing limits of our best land are a clear warning. If the results of the detailed partial surveys by our Soil Conservation Service, covering 270 million acres of land, are extended to the whole farming area of the nation, they reveal but 72 million acres of Capability Class I land in the United States, an area equal to only one and a quarter times the total area of Great Britain. This is land which can be safely cultivated by ordinary good farming methods without danger of serious depletion or erosion. It is all the cropland we have that, in a sense, takes care of itself. In Class II let us include, for simplicity, all of our remaining cultivable land that can be used for tilled crops, though much of it requires protective measures to prevent erosion, water-logging, depletion of plant food or accumulation of excessive amounts of toxic salts. Of this class we have 390 million acres. Beyond these two broad classes of land, which provide 3 acres per inhabitant, are permanent grassland, farm woodlots and wildlife preserves. Soil erosion now operates on a continental scale. Some of it is unseen except in a comparison of early and present soil profiles; elsewhere it reminds us of Indian scalping, the land left raw and bleeding. Once begun, such erosion may proceed at a rate one thousand or more times the normal rate of soil destruction.

This brief review of soil limits only sketches one problem that policy-

making must take into account. When we ship abroad the present excessive agricultural production, we are running the risk of, so to speak, exporting our patrimony or, as one observer puts it, the bones and teeth of future generations. Where is the line of danger? Artificial fertilizers are not the complete answer, as our older soils now reveal. Put plant breeding and hydroponics and climatology all together and we still do not have the complete answer. We have to press our search to deeper levels. In two-thirds of the United States, water conservation and controlled multiple use are now a major concern. Plant and animal physiology must be far more intensively studied with new techniques applied to trace elements, metabolism and physiological climatology before soil and water studies can be put into their full human context. In short, the answer is to be found in further and more intensive survey and experiment.

Our waning supply of first-class iron ores, our depleted lead deposits, our exhausted manganese deposits (always negligible) and a dozen other conditions in the mineral field give us intense interest in the remaining "pioneer lands" of the world, lands now either undeveloped or underdeveloped. What mineral resources do we see in them to replace those that we are expending too rapidly, what renewable growths of timber or increased production of vegetable oils? Such lands now take on a political significance as great as they had in the hey-day of naval power, but with different purposes in view. The question of their control is now more complicated than a hundred years ago. Without clear forethought, territorial advantages may be lost that the western democracies may quickly regret. I refer to the seeming inclination to consider long-held rights in outer territorial possessions as subject to unilateral cancellation. This is a reckless and dangerous interpretation of the ideals of the Charter of the United Nations in general and of the trusteeship principle in particular. The grand concept of trusteeship in relation to either colonial possessions or mandated territories is *purpose*, not mere change of control. We can no more indulge small and middle powers in their desire to take territory away from the great powers, on specious pretexts of need or propinquity, than we can assume that such desires and acts are the natural right of the great powers. We must collectively insist on the test of purpose. Equally we must insist upon capacity to assume the responsibility of carrying out agreements about purpose. Okinawa and British Honduras are examples that come readily to mind.

An immense new area of moral responsibility was opened by the trusteeship principle, a principle so sound that its thirty years of application has given it a moral strength that in my opinion assures its future. We saw it at work between wars in the 1920's and 30's; we saw it again in the Colonial Research and Development Fund of Great Britain provided during the late war and recently enlarged. It is reflected in the work of the joint British and American Caribbean Commission during and since the war. Its restraining force is seen in the territorial discussions that are an indispensable preface to the future disposition of Pacific islands that had to be wrested from the enemy at great cost of blood and treasure, and whose illicit seizure or fortification at some future day may again confront us with consequences that we ought to be wise enough to foresee and head off by timely and resolute action.

Relations within the western hemisphere

To what extent are the resources of the United States supplemented by the resources of Latin America? Does the western hemisphere form a self-contained economic system? Is there a natural solidarity of ideas and interests? What is at the root of Pan-American effort, political, economic and strategic? How one answers each of these questions depends upon the political weather. At all times Latin America has certain resources that we urgently desire to exchange for some of our own. War increases our need, and enhances that unpredictable variability of trade and policy that puzzles the European observer and at times upsets the calculations of some of the governments of Latin America. Some see in our western hemisphere policy a turning to isolationism, forgetting that we have the fixed policy, now of long standing, to assist democratic states in time of crisis, partly on political theory and partly because such a course increases our defensive strength. Hemisphere policy is not the policy of withdrawing into a shell. The ocean routes to most of South America are far longer than those to Europe. Ships and 'planes, not the isthmus of Panama, unite the two *economic* Americas.

Before drawing the conclusion that the policy of the United States is volatile and unpredictable, we should ask how much, if any, of the rest of the world is stable and predictable. Neither world production nor world export are closely calculable things. Every nation at times miscalculates—Brazil on coffee, the United States on cotton, Russia on rainfall, and all the world on oil. Industrially powerful, the United States is now in the position, long familiar to British government and business, that our business barograph feels the effect of every change in pressure anywhere in the world. All this gives added importance to areas of possible though relative stabilization. It is in this light that we view our trade and political relations with Latin America. It is natural that in time of general disturbance we should strive for hemisphere strength. As late as the spring of 1941 there was a strong sentiment, shared for a time by President Roosevelt, that hemisphere defence was practicable. When he invited me to express an opinion on the idea I stated that the setting of hemispherical limits to military defence was not practicable. A paragraph from that opinion follows:

"Since the foundation of the Republic it has been our settled policy to uphold the right of Americans freely to go and come upon the seven seas in pursuit of peaceful trade. . . . At times, however, we have deliberately and voluntarily restricted the sphere of our trade in the interests of neutrality and peace. At the outbreak of the present war, in accordance with Acts of Congress, American shipping was barred from war zones as defined by the President. Such a restriction was not imposed upon us by international law; it was based upon our desire to avoid entanglements that might lead to war. No foreign power has a right to request that such voluntary restriction of our trade be maintained, much less to request that we still further restrict it in the interest of totalitarian conquest."

A "free sea" position cannot be taken on paper only. A nation adopting that point of view must face the military implications, which are world-wide. Nevertheless, the American public has played with the idea of hemispheric self-sufficiency time and again. We shall therefore look in some detail at the

weakness of that position. The firmest and most spontaneous international association in America is between Canada and the United States. By contrast the bonds between Latin America and the English-speaking portion of the hemisphere, outside trade, are largely artificial. We do little about our natural Canadian-American friendship, while we are forever tending with anxiety our cultural and political ties with Spanish-speaking neighbours and Brazil. No amount of hemisphere talk quite stabilizes the bridge between us. Trade has not done it. Cultural embassies create extremely pleasant personal relations but leave the general situation untouched.

The cause of our division is to be found chiefly in our contrasting cultural inheritances and our different geographical environments. Geographical obstacles tended to keep the peoples of Latin America apart even among themselves. Each nation of to-day represents an earlier colony walled off by desert or mountain or distance from its neighbours. In origin, each nation was a geographically separated group. Even the major divisions of territory within a country suffered a like compartmentation; the histories of Mexico, Bolivia and Argentina afford many examples right down to our time. For a whole century, revolution was easy in every Latin-American country because the several communities within each nation were neither contiguous nor effectively interlocked. Local differences are known in all countries. In Latin America the political expression of internal cohesion has been most difficult to attain and impossible to hold for long.

Contributing to the same end was the marked (and still existent) regionalism and cultural contrasts in Spain and Spanish history for at least a millennium. The cultural capital of early colonial Chile or Peru or Mexico was not Madrid but some provincial Spanish town. The provinces of Spain are no less distinctive than the colonial groups that formed in Spain's vice-royalties. The Spanish system of fleets and fairs, established in 1561, continued almost down to the time of the American Revolution. Only as late as 1774 was the prohibition removed on direct trade between New Spain, Peru, Guatemala and New Granada. And it was not until 1778 that the port of Buenos Aires and the ports of Chile and Peru were open to direct trade with Spain. Fragmentation, both natural and enforced, was deemed a principle of imperial control and lasted for nearly three hundred years.

With weak internal cohesion, each new government that emerged from the Wars of Liberation was preoccupied with merely holding on, and only a few individuals, among whom Bolivar was foremost, thought in terms of western hemisphere trade and political union. Unaccustomed to constitutional forms, the first national groups of little more than a hundred years ago found themselves in possession of a simple *theory* about rights, and confronted with the complex *duty* of operating a democratic government without any established tradition of compromise. Lacking the patience to run that ponderous and at times baffling machinery, and without sufficient respect for majority vote on the part of a small electorate, control became an affair of families rather than proven political leadership, while office became a privilege and too often a badge of unwarranted prestige. The national economy became a medley of forces little understood. Wealth was in land and minerals and livestock. Native populations and mixed blood groups constituted the

masses from Mexico to Bolivia who long had little or no representation in elections or office. The pack mule, the trail, the simple exchange of goods at weekly, monthly or annual fairs, the dependence on foreign capital, foreign reduction-plant, and foreign demand and consumption of mineral and other raw materials, were the enduring marks of a primitive economy whose controls lay outside Latin America.

The nervous relation of Latin America to the United States to-day depends in part upon these contrasts in cultural backgrounds and traditions and in part upon a disparity of military and economic power. The feeling is accented by differences in political and social philosophy. A poet sums up one such contrast, no less true of Latin America than of Spain, when he writes: "God bless those who labour and we who guide them." To the traditional ruling class it is nonsense to claim that the peon knows what is good for him in government or society. "Look at him," it will be said, "the answer is in his face and bearing." The official will add that few are those who understand complex public policies and those few have acquired their abilities over the centuries. The heroic supplies an ingredient to the composition of Spanish rulership that has not lost its flavour and should not be undervalued, for some of its essence sifts down in variant forms through all classes of Latin America. Nobleman and priest stood together on many a critical battlefield where the cross overwhelmed the crescent in Spain's historical yesterday.

Underneath the veneer of popular government in the new Latin sovereignties of a hundred years ago were institutions that supported, if they did not create, a new political élite. The bride changed her name but not her initial. The Spanish officials were gone but the land baron remained in possession of estates derived in many instances from original *encomiendas* or their subdivisions. The institution of the *hacienda* was continued as naturally as if it were divinely ordained, for it had a powerful economic and social base. Land was the commonest and most reliable form of wealth. Grants of land were the coveted rewards of valour in the days of the Conquest and were consolidated by marriage or transferred and perpetuated, some of them down to our day. With the land and water went rights to a part of the labour of those, chiefly Indian or mixed breeds, who lived by sufferance upon it.

Labour, whether on the land or in the towns, is the core of the present-day internal difficulties of Latin America. Those who wrote the constitutions that were the sequel of successive revolutions never forgot the resounding phrases of the vice-regal grants made as rewards for loyalties kept, services rendered and risks endured. Until the Mexican revolution less than forty years ago it was never intended that a new constitution should affect land titles or eliminate special privileges. A new government meant a change of masters, not a change in the economic or land-tenure systems. If reforms were promised, they met the same fate as the ideals respecting native labour and fair dealing in the famous "Recopilación de Leyes" of the Indies of colonial times, ideals expressed in faultless rhetoric and a noble humanity but with little ensuing effect.

The rôle of land in Latin-American economy is not generally understood in the United States, where the "homesteads for freemen" principle has affected policy with varying success since Benton's day, for over 125 years. To many

minds the answer to the tough problem of refugees and displaced persons is, "there is plenty of land in South America." To reach that confident answer one merely divides a number representing the population by a number representing square mileage and one sees how relatively empty South America appears to be! In 1938 the Banco Agricola del Peru in Lima distributed a paper by R. A. Ferrero significantly entitled, "The scarcity of cultivated land in Peru," meaning arable land with a tolerable climate and with some prospect of having or getting transport without which a remote production system in a far valley had no hope of success. There are a number of Latin-American regions, upland Brazil being the largest, where arable land is available but burdened with troublesome problems of transport and markets. Always excepting the upland interior of Brazil, it is a hard fact that the total of undeveloped arable land in Latin America is small. Its development will be slow because most of the land is marginal. The population of Latin America is growing rapidly, even alarmingly. At the present rate it may double in a century; it will push out to the potential limit of land development, but it will not change greatly the land-occupation map. Its further strength and fortune will be built upon industry added to land. It will not be based upon a new generation of land-seeking pioneers. The land is not there. The best of it is already cultivated.

The large Indian population of parts of Latin America creates a special problem and, in places, presents an impenetrable iron curtain to the white overlords, as among the Aymará of the Central Andes. It is idle to talk of universal suffrage and democratic majority procedures to an Indian group ignorant of political theory, incapable of choice and walled off by centuries of deep-seated hostility towards whites. Out of a total population of seven millions in Peru, two and a half millions are upland Indians who do not speak Spanish. Ability to speak and write Spanish being a requirement for the citizen desiring to vote, the electorate probably does not exceed 800,000 or 10 per cent. of the population. Arca-Parró's work on the census of 1940 is a landmark in the analysis of the population structure of Peru. In the United States we have no such masses of indigenous population to bring so far forward. Our Indian population of 400,000 is a minor though still grossly neglected problem. The white citizens of Guatemala face white-Indian ratios of 9 to 13. For the United States the equivalent would be an Indian population of ninety millions! We are not prepared, therefore, either to criticize the policies of Latin-American states or to display examples of better conduct. The irreducible fact is that in half the Latin-American countries colour and race and wide economic inequalities introduce strains and risks that frighten foreign capital. A country that cannot reduce the risk is penalized by high rates of return on capital. The economy pays double—once for domestic dislocation, and again for using outside money to develop its resources or finance its trade. The foreigner is alternately courted and disliked in Latin America. To-day national sovereignty means more than flag and sentiment. It means also economic handicaps, irreducible native problems, a lack of cohesion even in the top layers of society where opposing groups strive for the privileges of government rather than for its use as an instrument of national improvement and solidarity. Unity and stability are not there.

How shall we weigh the Latin-American nations in the scales of western hemisphere interests? What strength do they contribute to a unified hemisphere or a world policy of peace and defence? In World War Two we found them cooperative, understanding the vital issues. We needed their products and they needed, as never before, our markets. Transport was chiefly at our cost and the ships lost to submarines were chiefly our ships. To oil, coffee, tropical fruit, copper and tin among leading Latin-American imports, were added cotton, manganese, industrial diamonds and quartz crystal, to mention only a few products; and through all this there ran a great deal of preclusive buying. Argentina had exports, mainly livestock, of 700,000,000 pesos in 1940 and of 1,350,000,000 in 1944. All benefited marvellously considering the times. Yet all knew that a day of reckoning was coming. Where would they find themselves in the crisis of post-war reconstruction?

A new cloud of anxiety darkened the Latin-American sky as the discussion of a world charter proceeded at San Francisco in 1945. Communism threatened both Church and State in these Catholic countries. As in old Spain, common cause was made by the representatives of the existing different governments against the possibly extreme positions of the rising and politically immature lower middle class and the third estate. What part would Soviet Russia play in the expected revolutions? When the difficult question of the admission of Argentina arose in the United Nations there was presented an opportunity to give positive expression to the fear of communism by opposing the Soviet position. Astonishingly enough, security was sought by Latin-American representatives in a hemisphere agreement, with United States leadership implied in matters political and military. Hemisphere interests were considered to be ahead of world interests. The Act of Chapultepec carried a provision for a future military agreement on hemisphere defence. The representatives of the United States agreed to meet the representatives of Latin-American countries in 1946 to forge an instrument of closer collaboration. It was impossible to keep this pledge because of preoccupation with European problems and delays arising from Soviet intractability. The Bogotá conference was held two years too late. The riots there, and in Cartagena and Barranquilla, only underscored what was long well known, that no guarantee of stability appears on the political horizon; and every revolution is marked by attacks upon the large property owners and upon the position and profits of the foreign investor and producer.

Thus is the soil prepared for the Communist sowing, as it was for the Nazi sowing. A solution based on force is fatally attractive where there is weak internal unity. Only the files of the intelligence services could disclose the wartime scale of Nazi divisive influence in more than half the countries of Latin America—in the commercial companies, in the army, among the "citizens" of foreign origin, among office holders and members of national congresses. The joining of American and Soviet interests for war purposes gave Communism for a time a field day in Latin America. The fantastic and costly wartime expansion of Soviet embassies in Latin America was not done in a fun-loving or peace-making spirit. The flaming torches of Bogotá were a demonstration that there is much fuel at hand. It could happen in twenty other South American cities. We do not know and shall not know, until a

cycle of profound change has been completed, what the long pull ahead of us will disclose. We believe that we cannot make and keep friends, even though both sides recognize the artificial quality of our friendship, unless we keep our political and social aims in parallel. To do this, all the resources of science, diplomacy, goodwill, economic improvement and steadfastness will be required, and above all resolution and patience.

Responsibilities in the Far East

Air bases and shortened distances, naval ports and facilities, and clear lines of supply are elementary requirements for any nation that defends the principle of a free sea. No spot of land anywhere can therefore be thought negligible. The map of the Western Pacific and its lessons for the future have become familiar to everyone. Not so clear perhaps is the meaning of East Asia and its peninsulated coast and narrow seas. The future control of Japan is meaningless unless the land and sea approaches are also defensively controlled. The yardstick of distance and area to be defensively controlled is now the supersonic 'plane and missile.

To weigh these elements of Far Eastern strategy is to state but half the problem. The other half is trade and political doctrine. When President Monroe's famous western hemisphere doctrine declared against the extension to the New World of the territorial control and political systems of European states, he could not foresee the European Recovery Programme or forecast to-day's discussion of a foreign alliance by the United States with a military aid provision. The vitality of the western hemisphere idea is no longer dependent upon the maintenance of a political curtain drawn down over the Atlantic. Pan-America is based upon mutual interests. To search out such interests, create new ones, strengthen cultural ties and re-define social and political aims are now the tasks of hemisphere diplomacy and education.

The present allied beach-head in the Orient is not one of the dilemmas of victory. It is to-day to our western mainland coast what Pearl Harbour was before 1941 as a naval and air outpost. It is an exaggeration to say that the Pacific has shrunk to the size of a moat; surface ships will always find its vast distances a main factor in supply. But both air and sea operations have to take account of air speeds from scores of bases that lie before us on the map of Eastern Asia. If large and presently helpless populations are to have time to think out their future problems, to experiment in their solution and to give free expression to their political ideas—if, in short, any territory is to be won for democratic ideals, the Far East is not a responsibility of the moment. We must be there to stay. A Far Eastern doctrine is more vital to a free sea and to fair trade practices than that involving any other territory in this broad question. It is a doctrine that, like the Monroe Doctrine, is designed to give freedom a chance among politically immature nationalities and peoples. The Philippines are an example of opportunity realized in a half-century of steady progression toward well-defined goals.

In American eyes and from a military point of view, there is no desire to belittle the value of arctic routes and antarctic territorial problems, or the part Africa plays in a comprehensive design for world security. But our thought is concentrated upon the problems of three areas that have superior weight and

complexity: Europe, Latin America and the Far East. In two of the three are vast powers of recuperation, organization, production, partnership in the United Nations and, above all, the will and the capacity to nourish the ideals and the best traditions of a Christian civilization. These powers, joined to our own, cannot be overthrown by outside pressures alone; their inner vulnerability requires equal attention. Freedom is freedom without qualification. There has now been set in train a process that utilizes freedom for freedom's own destruction.

The long-range view

The historical record shows that most long-range prophecies respecting human welfare are confounded by unexpected developments in technology and politics, and by new social ideas and forms of international collaboration. Only in a totalitarian or fully controlled state can social events be predicted because only there can the controls be applied so as to justify the prediction. I will not venture, therefore, on an imaginative excursion into the future of Rhodesia or interior Brazil or northern Canada. Still less am I inclined to outline the future of Siberia in a world whose capacities for development are no sooner appraised than the forces of life invalidate the appraisal. Not a national Domesday Book but an international political and economic year book is now a basic requirement of our fast-moving times.

It is painful to admit in 1948 that mortal danger is our daily preoccupation and political guide. In the stress of war we discovered the atom bomb, the most terrible thing in the world, and now we have to reappraise the world and every piece of territory in it to see how that danger will operate if unhappily it comes into play. We have also to examine the fundamentals of our political faith. Where do we stand morally; who are the friends that will stand beside us; how shall we implement friendship? How are stout political bonds to be woven on the shaky loom of time and fate? We can no longer permit cultural distortions, political distortions, land-use distortions, because food and well-being and a unified society are first requirements. We cannot talk of faith and ideals and bonds of friendship unless we are reasonably well fed and march forward with confidence in our internal unity.

Confronted by the world's irreducible diversities we have to recognize what might be called a new theory of coexistent, multiple systems of politics. Complex and difficult as the world will be to operate without war, the road seems to me to be clearly marked out for us, the road of complex relations extremely difficult to manage but requiring management in all their complexity. Those who grow impatient with this complexity and fear both war and the risk of war, fly to those simplicities and fallacies that are opiates to the general. Some of the fallacies may be set out roughly as follows: that one can get world peace always and everywhere without war; that securing it by magic, we can keep it by an agreement about words on a page; that we can skip five or six consecutive steps and get peace and security at one jump by proclamation.

It is clear that while we may talk of the geographical situation of the United States in relation to world policies, we cannot think in geographical terms alone even though we may emphasize geography because it has been so long

neglected. We must think in terms of the whole plexus of circumstances that surround us. This is a hard intellectual exercise. Our chief difficulty in the democracies is to get men thoughtfully engaged in the exercise. It is so much easier to deal in simplicities and broad generalizations, or search for salvation in a single idea, or think ourselves secure because of a recent military victory. All must realize that the boundary between war and peace can be smudged with resulting disorder and danger. Events and ideas are now involved in a vast turbulence which statesmen must direct into strong and positive currents.

The great design for peace has yet to be forged. I say this, in spite of constant personal devotion to the United Nations, because the world has not yet demonstrated that steady will for peace that is the first condition of it. The dangerous over-confidence of Russia, its exuberant faith in a distorted and cruel system, is the mainspring of our troubles to-day. I have faith that we shall surmount these troubles as we have done before. I am encouraged by examples in our past history. A quotation entitled "The lesson of the day" forms a fitting conclusion to this review:

"It is a gloomy moment in history. Not for many years—not in the lifetime of most men who read this paper—has there been so much grave and deep apprehension; never has the future seemed so incalculable as at this time. . . . In France the political caldron seethes and bubbles with uncertainty; Russia hangs as usual, like a cloud, dark and silent upon the horizon of Europe; while all the energies, resources, and influences of the British Empire are sorely tried, and are yet to be tried more sorely. . . . Of our troubles no man can see the end. . . . These are the things that make the profound interest of the moment, besides others whose roots are spreading underground, out of sight. It is no time for idleness or trifling, for forgetfulness or selfishness. The complexion of every country, and of the world, rests at last upon the character of the individuals . . ."

It is a quotation from *Harper's Weekly* for 10 October 1857, and describes a situation that seems overdrawn, as we look back upon it. Perhaps it is no more overdrawn than the American view to-day of British and European difficulties, or the American doubts about future British policy until your own recently sharpened criticisms of Leftist forces.

The above paper was read at the Evening Meeting of the Society on 21 June 1948.

DISCUSSION

Before the paper the PRESIDENT (The Rt. Hon. LORD RENNELL OF RODD) said: This evening we have been fortunate enough to secure Dr. Isaiah Bowman to read a paper on the geographical relations of the United States to world policies. But before calling upon him to read it I shall have the pleasure of presenting, not only to Dr. Isaiah Bowman but also to Mr. Owen Lattimore, Gold Medals of the Society which were awarded to them during the recent war when we were unable to present them either in person or in kind. At the time both gentlemen received what amounted to an "I O U" for a medal. Mr. Owen Lattimore was awarded the Patron's Medal in 1942 for his travels in Central Asia. The Patron's Medal for the year 1941 was awarded to Dr. Isaiah Bowman. It is a curious and

happy coincidence that Mr. Owen Lattimore is on the staff of Johns Hopkins University as Director of the Walter Hines Page School of International Relations, while Dr. Isaiah Bowman, as you know, is now President of Johns Hopkins University. We are thus able to send Mr. Owen Lattimore his medal by the hand of the titular chief of his university.

Dr. Isaiah Bowman is of course known to you as perhaps the most distinguished American geographer of our generation, and distinguished for many reasons: because he was Director for so many years of the American Geographical Society, therefore for the work he has done for geography in the United States; particularly distinguished for his own work on South American geography in the field and for his travels in South America; and, last but not least, distinguished for having been the instrument through which the American Geographical Society produced the greatest map ever published of any one area, the map of Hispanic America on the scale of 1 in a million, conforming to the style of the International Map. The 107 sheets cover an area of approximately 8,000,000 square miles, extending from the Mexico–United States border to Cape Horn, including the West Indies. The last sheet of the map, the culmination of Dr. Isaiah Bowman's work, appeared in 1945. We are very glad to record this achievement here in his presence as a monumental feat in furtherance of geography.

But that is not the end of the claims that Dr. Isaiah Bowman has on all of us. He has also been prominent in the world of foreign affairs and political science, on which he is going to speak this evening. He was an adviser to the American Peace Commission in 1919 and was present at the Peace Conference. In the latter years of the recent war Dr. Bowman served the United States government and the Allied cause. He was, with our eminent guest Lord Halifax, at the San Francisco Conference. He has been a member of the Board of Directors of the Council on Foreign Relations, and between the wars was vice-chairman and director of the Science Advisory Board appointed by President Roosevelt in 1933. It was from there that he became one of President Roosevelt's advisers on strategic geography and post-war international developments.

Before I call upon Dr. Bowman to read his paper I am going to ask him first to accept on Mr. Owen Lattimore's behalf the Patron's Medal for 1942, and then to receive from the Society on his own behalf the Patron's Medal for 1941.

Dr. ISAIAH BOWMAN, on receiving the medals: It is with great pleasure that I acknowledge your kindness in presenting me with the Patron's Medal of the Society, and in bestowing the same medal for 1942 upon my colleague Owen Lattimore. We are extremely grateful. In my own case I feel that all my professional associates over the years share in the honour. We were members of a team working together for the advancement of scientific geography in a world of baffling yet exciting geographical and cultural diversity that must somehow be brought into harmonious working relations.

Dr. Bowman then read his paper.

The PRESIDENT: There is only one in the Hall to-night who can adequately comment on Dr. Isaiah Bowman's paper, and that is Lord Halifax.

Lord HALIFAX: I certainly should not be presumptuous enough to try to add anything to what Dr. Isaiah Bowman has said, nor indeed should I be bold enough to comment seriously upon it without opportunity for reflection, because I do not think that any of us can ever have listened to an address that covered so much ground, that covered it so wisely, that touched on so many points and that was so stimulating in the number of avenues down which it pointed the way for us when we have the leisure or the inclination to walk them.

Therefore it would be the last word in presumption to do what you, Mr. President, have suggested.

But as I was listening to the address I had two reflections. One was how fortunate I have been as Ambassador in the United States to have had the opportunity of establishing what I hope without presumption I may call a measure of friendship with Dr. Bowman over several years. I was fortunate enough to see him on a good many occasions, to know something of the work he was doing over critical years in the State Department when, as he reminded us, he was adviser to successive Secretaries of State. I had the privilege also of working with him for many weeks at San Francisco when we were occupied with the United Nations Charter. Before we came to this meeting he was reminding me and others here that we were from time to time confronted with the frustrating and baffling silences of the representatives of Soviet Russia. Therefore we have a good deal of background in common in these past associations. That was one of the pleasant group of recollections that came to my mind as I listened to Dr. Bowman, and I judge myself very privileged to have been among his audience to-night.

My other reflection was this: I wondered whether it would have been possible or likely for an American representative thirty years ago to have given a similar address to that to which we have listened to-night. I do not know what Dr. Bowman would say to that. I hardly think that it would have been very probable. And I often think that we are perhaps too close in time to appreciate how revolutionary has been the change in American thinking over the last quarter of a century on all these immense world problems that Dr. Bowman has touched on to-night. Being able to watch some part of that revolution at close quarters, one was gripped and fascinated by the growth and movement of thought of a great people who, as Dr. Bowman implied more than once, were holding on to certain fundamentals and following them through to see where they were leading them in their place and duty in the world.

I remember once—and it made a great impression on me—hearing General Marshall say something that I do not think he would mind me repeating because it was a very simple expression of his thought. The war was still going on but was obviously drawing to a close, and one day we were talking about the end of the war and how things would look. General Marshall said to me: "The war is going to leave the United States in a position of immense responsibility. There is no instance to cite in history of a nation so young being faced with such responsibility and God only knows whether we shall be worthy of it." As United States policy has developed over the last years I have often remembered that saying, and I often suppose that General Marshall's hopes are being fulfilled—and he largely has been the architect of their fulfilment—as we watch the evolution of United States policy. Watching it, we can never forget what an astonishing thing it would have been some twenty-five years ago to find the United States interested in Azerbaijan or in Trieste or in Korea or in any of the matters and places that are taken for granted to a great extent by American opinion to-day. That is why I judge that evolution to have been of a revolutionary order. The truth is, I suppose, that with the contraction of the world, for reasons with which we are all familiar, the old conception of the relation of geography to policy—a ground on which I tread with extreme delicacy—has been somewhat modified and recast. At one time it was possible for a country to look at the world and say: outside that line we are not prepared to be vitally interested, we will sit back and it does not much matter what happens. That is no longer possible. Moving into an era when the affair is not one of frontiers but of ideas that know no frontiers, you can no longer enjoy that measure of

disinterested security because everything is bound to interest everybody everywhere. Therefore you look to Azerbaijan, Trieste, Korea and so on.

The second reason, I suppose, is that in a mechanical and industrial age the power in the world—and the world is still influenced by power and will continue to be—tends to fall into hands that are industrial or that have control of uranium, or whatever may be the test of the day as to what constitutes power. And whoever is powerful tends to become the sponsor of groups and the world tends to be divided into a few small groups. All that helps to make interest very close. However, I must not break my own good resolution, which is not to expose my ignorance on the subject of to-night's paper. As you insisted, Mr. President, on dragging me from my chair let me return to it expressing my profound gratitude to Dr. Bowman for the stimulating address to which I consider myself very fortunate to have been allowed to listen.

The PRESIDENT: The gratitude which Lord Halifax has expressed I pass on to Dr. Bowman. We have heard a memorable address in a very memorable year. What Dr. Bowman has left with us to think about is what has been at the back of the minds of very many of us without having hitherto been so overtly expressed. Dr. Bowman spoke of the impossibility of a state of equilibrium in a living world. But he spoke of another thing too: the time when people would speak of rights has given place to a time when people must speak and think of duties; the era of the Bill of Rights has passed, to be replaced by a Bill of Duties. To this Dr. Bowman and his friends in the United States have devoted their time, and to this we must be willing to devote the rest of our lifetime. On your behalf, I thank Dr. Bowman for what he has given us to think about. I thank him very especially that he should have come to say it to this Society.

ARNHEM LAND: EXPLORATIONS AMONG AN UNKNOWN PEOPLE

DONALD F. THOMSON[1]

PART I. THE JOURNEY TO BENNET BAY

ARNHEM LAND, WHICH lies in the north-east corner of the Northern Territory, was the last great tract of country in Australia to be explored. Up to 1935 almost no information was available about the area and its native inhabitants. No official anthropological survey had been made and the natives had never been brought under control.

It is a region of great ethnographic and historical interest, but for more than a century after the coming of Flinders it was shunned by the white man and remained a vast untamed No Man's Land. For many generations voyagers from Indonesia paid annual visits to the coast of Arnhem Land in their *praus* in search of trepang or *bêche-de-mer*, pearls and tortoise-shell, coming down with the north-west winds and returning with the south-east. Long before the settlement of Australia by the white man, they had established a good working relationship with the natives. In 1803, Matthew Flinders[2] in the *Investigator* encountered a fleet of six Malay praus on the north-east coast of Arnhem Land between the chain of islands which he named the English Company's Islands, and the mainland. These praus were under the command of Pobassoo, who informed Flinders that there were no less than sixty such craft on the coast of Arnhem Land at that time, all owned by the Sultan of Boni, and that they carried a total of about a thousand men. Pobassoo also told Flinders that the commander-in-chief was Salloo and that this fleet came from Macassar in the Celebes. He said that he had himself made six or seven voyages to Arnhem Land over the past twenty years and that he had been one of the first to come. This would set the time of the first visits by these Indonesian voyagers at about 1780. But the evidence of Asiatic influence on this coast, which Flinders had already recorded on this voyage before his meeting with Pobassoo, indicates that these visits were probably of considerably greater antiquity than suggested by Pobassoo.

These visiting voyagers from Indonesia exercised a profound influence on the natives of Arnhem Land, which can be seen to this day. They established a good working relationship with the people and they left behind a tradition of respect amounting to hero worship which still remains.[3] There is no doubt that failure to appreciate the history of Arnhem Land has been responsible for

[1] Dr. Thomson, who is a Research Fellow in the Department of Anthropology, University of Melbourne, was awarded the Cuthbert Peek Grant for 1948 for his contributions to our knowledge of Arnhem Land. The circumstances in which Dr. Thomson carried out this work are described in a note in our last issue (*Geogr. J.* 112 (1948) 124).

[2] Matthew Flinders, 'A voyage to Terra Australis,' vol. 2, pp. 229–33, 1814.

[3] Flinders however suggested (*op. cit.*, vol. 2, p. 198) that the natives did not hold the Asiatic visitors in much regard.

the extreme hostility which the white man and the Japanese met subsequently in this area. Visiting seafarers were expected to conform to the pattern of conduct which had been established, which included a respect for the integrity of the women, and to recognize also the territorial and other rights of the natives, as the Macassar trepang fishermen had done. Too much stress was laid by the white man on the primitive and savage disposition of the people, whereas we know now that as a result of their long contact with overseas visitors of a more advanced culture, they were more sophisticated than any other Australian aborigines, a fact which was noted by Matthew Flinders nearly a century and a half ago.[1] He was impressed with the bold, independent, almost *blasé* air of the people of Caledon Bay even as long ago as 1803. Of their meeting on Friday February 4 with Lieutenant Fowler whom he sent ashore to make contact with the natives, Flinders remarked: "They staid to receive him, without showing that timidity so usual with the Australians." Again, a few days later he wrote: "That this bay (Caledon) had before received the visits of some strangers, was evinced by the knowledge which the natives had of fire arms; they imitated the act of shooting when we first landed, and when a musket was fired at their request, were not much alarmed. . . . The propensity shown by the natives to steal, especially our axes, so contrary to all I have known and heard of their countrymen, is not only a proof that they had been previously visited by people possessing iron implements, but from their audacity it would appear that the effect of fire arms was either not very certain in the hands of the strangers, or had seldom been resorted to in the punishment of aggression," and he added, " . . . I have some hope that those who may follow us will not be robbed, at least with so much effrontery."

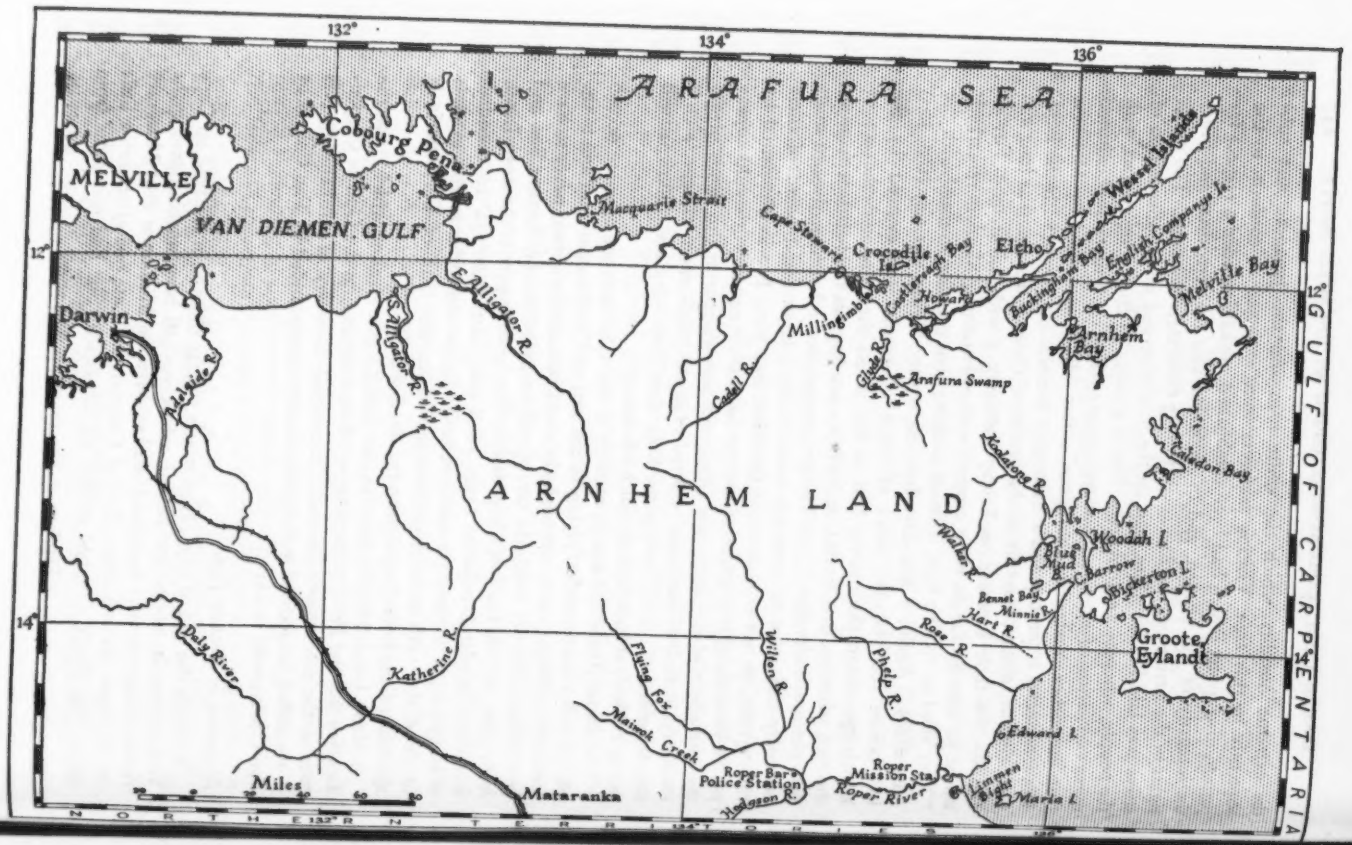
The name Arnhem Land is applied to the vast territory of some 60,000 square miles (map overleaf) lying to the east of Van Dieman Gulf and to the north of the Roper river, although the exact boundaries appear never to have been defined. In the north the territory is bounded by the Arafura Sea, and in the east by the Gulf of Carpentaria. The greater part of Arnhem Land, including the islands adjacent to the coast lying east of the 132° 20′ meridian of longitude, is nominally a native reserve. In the south this reserve extends to about the 14th parallel of latitude, but as the Gulf of Carpentaria is approached the boundary dips to the south a little.

Arnhem Land owes its name to the Dutch yacht *Arnhem* which, with the *Duyfken* and the *Pera*, made voyages of exploration into the Gulf of Carpentaria in the seventeenth century. The actual discovery of Arnhemsland, as it was called, is credited to the yacht *Arnhem*, commanded by Van Colster or Van Coolsteerdt, in 1623.

Massacres in Arnhem Land

Towards the end of 1933, after nearly twenty months in the field on Cape York peninsula, north Queensland, where we had been working among the native tribes, my wife and I had reached Mapoon Mission at Port Musgrave on the lower Batavia river, Gulf of Carpentaria. Late one afternoon a little cutter, the *Oituli*, dropped anchor off the beach. She had just come from

[1] Flinders, *op. cit.*, vol. 2, pp. 205, 213.


132°
134°
136°
ARAFURA SEA
Cobourg Pen.
MELVILLE I.
VAN DIEMEN GULF
Macquarie Strait
Cape Stewart
Crocodile Is.
Castlereagh Bay
Elcho
Howard
Buckingham Bay
Wessel Islands
English Company Is.
Melville Bay
Arnhem Bay
Darwin
Adelaide R.
S. Alligator R.
E. Alligator R.
Millingimbi
Cadell R.
Glyde R.
Arafura Swamp
Koolatong R.
Caledon Bay
ARNHEM LAND
Woodah I.
Blue Mud B.
C. Barrow
Bigiarton I.
Bennet Bay
Minnie R.
Hart R.
Rose R.
Groote Eylandt
Walker R.
Daly River
Katherine R.
Flying Fox
Maimuk Creek
Wilton R.
Phelp R.
St. Edward I.
Roper Bar Police Station
Roper Mission Sta.
Limmen Bight R.
Hodgson R.
Roper River
Maria I.
Mataranka
Miles
GULF OF CARPENTARIA
12°
14°

Groote Eylandt on the opposite side of the Gulf of Carpentaria, and her crew brought news of serious disturbances and fighting in Arnhem Land. We learned of the massacre of the Japanese crews of two trepang luggers at Caledon Bay, of the killing of two white men at Woodah Island in Blue Mud Bay, of the ambushing of a party of Northern Territory Police and the spearing of Constable McColl, also at Woodah Island, and of the withdrawal of the police reinforcements. And we learned that the Administrator of the Northern Territory was even then pressing for a punitive expedition to quell the natives of Caledon and Blue Mud Bays. From past experience we knew what such an expedition would mean to the natives.

There were reports that the natives of Arnhem Land were massing for an attack on Groote Eylandt, an appeal was made for protection of the Mission there by a police party, and broken glass was actually scattered about the Mission to deter the natives. Finally it became necessary for the Attorney-General of that time, Mr. (later Sir John) Latham, to declare in Parliament: "A legend has arisen in other countries that Australia was about to begin a war in North Australia, and the Federal Ministry had to remove several misapprehensions." A state of affairs unprecedented in the history of Australia occurred. The people of the Northern Territory were still planning vengeance, and the Government were seriously embarrassed. Arnhem Land had never been brought under control. There were no patrol officers, no Government officials, and no organization in this territory responsible for the maintenance of law and order.

For me this was momentous news. Scientific methods had never been used by the Commonwealth Government in the administration of native affairs. Here was an opportunity which might never occur again in my lifetime, to demonstrate once and for all the value of an anthropological method of approach and to avert disaster for the natives. For several years I had been working among the nomadic aborigines of Cape York peninsula. I had lived and hunted with them, learned their customs and their languages. I understood these people and believed in them and I resented the injustices under which they had suffered for so long.

I wrote at once to the Chancellor of the University of Melbourne, from which I was working as Research Fellow, and asked that he suggest to the Commonwealth Government that I should be entrusted with the task of going alone into the troubled area to establish myself among them and to make a study of the natives, to learn the real causes underlying the fighting and unrest, and to endeavour to restore peace among the warring groups. I offered to settle down and live with these people to make a thorough study of their language, social organization, moral and legal codes, and to remain with them, if necessary, for years. I was recalled to Melbourne from Cape York peninsula by the Chancellor (Sir John MacFarland), who offered my services to restore peace and to investigate the causes of unrest in Arnhem Land and to advise the Commonwealth Government on a policy for the administration of native affairs in the Territory.

I was warned on all sides that it meant certain death to enter the area alone, and this feeling had also been communicated to the Chancellor. It was some time before I could convince him that my plan was sound. But once he was

convinced he gave his whole-hearted support. I did not know the natives of Arnhem Land, but I did know the aborigines of north Queensland with whom I had worked for some years. In vain I tried to convince the Government that there was nothing either heroic or suicidal in this offer. I was sure that the methods which I had used to win the confidence of the natives of Cape York peninsula would also be successful in Arnhem Land. The Australian aborigine is normally of a peaceful and genial disposition and his attitude towards the white man is generally friendly unless he is greatly provoked. I was convinced that there must be a very real cause underlying the constant warfare reported from Arnhem Land.

I want you to think of the undertaking like this. I had followed as closely as I could the occurrences in Arnhem Land in 1933 and I did not agree with the popular estimate of these people as treacherous "murderers." To me they were a group of primitive people still clinging to their heritage, who had dared to defend their birthright against violation and aggression. In this spirit my plan was laid. It was an attempt to understand the people, to formulate their problems and to interpret these to the white man. But scientific methods had never before been used in native administration in Australia and prejudice dies hard.

This was the first time an Australian Government had entrusted such a mission to one man and the foreboding which was rife is reflected even in the official commission which was handed to me. After setting out the task I was to carry out, it ended with the benediction "with every good wish for your safety and success in this enterprise." More than twelve months elapsed from the time the offer was made until I found myself entrusted with a commission to proceed to Arnhem Land for two years—a roving commission to establish friendly relations with the natives, to instil into them the elements of the white man's law and to make a survey of their culture,[1] and I was at liberty to carry out the job in my own way and outside the control of the Administrator.

In the meantime, through the generosity of two Australian citizens, Messrs. A. M. and G. R. Nicholas who presented the necessary funds, an auxiliary ketch of about ten tons was purchased for this special work. This craft, although only 42 feet in length, had been stoutly built in Tasmania of Huon pine. I had already made one voyage in the stormy Bass Straits in her and had made a landing on Albatross Island, and I knew that she was strong and seaworthy. She was called the *Westaway* but was renamed *St. Nicholas* in honour of the donors.

[1] The final decision to abandon the proposed police or punitive expedition, against which there had been a great public outcry in the press, echoed all over the world, and the final acceptance of my own offer—the decision to apply for the first time in Australia, in a crisis in native affairs, an anthropological method of approach—was due largely to the combined efforts of the Chancellor, Sir John MacFarland, and Professor F. Wood Jones, F.R.S., my guide, philosopher and friend, and to the enlightened view of the Federal Attorney-General, Sir John Latham, now Chief Justice of the High Court of Australia. I received also much sympathetic interest and support from Professor D. B. Copland, Acting Vice-Chancellor of the University of Melbourne.

The first journey

On 16 March 1935 I left Melbourne on board S.S. *Ormiston* for Cairns, where I took over the *St. Nicholas* which had been delivered at that port and was awaiting my arrival in charge of the harbour master. Fuel supplies for the auxiliary motor and stores sufficient to last many months, as well as several caddies of tobacco, coils of heavy gauge wire for fish spears, fish hooks and other trade goods were obtained. Then followed several days of stowing cargo in the sweltering hold.

I enlisted three local natives—a half caste and two aborigines—to serve as crew on the voyage to Torres Straits. At last the vessel was ready for sea and, on the afternoon of April 4, I sailed from Trinity Bay on the run to Thursday Island about 500 miles away. This was my first voyage on the open sea in charge of a ship, and the voyage up the Barrier Reef was a notable one with many anxious moments. The sight of the mountains of the Lockhart river 350 miles north from Cairns was like a glimpse of home, for there I had spent some of the best years of my life with the dugong hunters and seafarers; living, as nearly as a white man can live, the life of a nomadic hunter.

At Lockhart river I found Tommy (Tjamindjinyu) waiting for me. Tommy had been with me on all my previous expeditions in Cape York peninsula and I knew his language well. He was eager to accompany me, and having recruited two other natives who had also been with me on previous expeditions, I left the men I had brought from Cairns to be returned home from Lockhart river. We sailed northward to Thursday Island, where I had intended to "sign on" the crew of Queensland natives to serve with me in Arnhem Land. But after a few days, even those men whom I had known for years came under the spell which had been following me all the way up the coast—the feeling that I was bound for that bourne whence no man returns. Told that I would certainly be killed in Arnhem Land, they eventually left me.

Following the defection of my Queensland crew I obtained three Torres Straits Island natives to man the *St. Nicholas* on the voyage to Arnhem Land. Lack of funds at this juncture however made it necessary to return two of the three men on arrival at Groote Eylandt and to depend on bush natives, recruited casually, to work the boat in the almost uncharted waters of the Arnhem Land coast.

It had been my plan to work slowly around the coast to Blue Mud and Caledon Bays. I had, however, been warned repeatedly of the danger of having my boat raided by the natives on the coast of Arnhem Land. This, coupled with the fact that I had to depend on a single Torres Straits Islander whom I did not yet know, and who did not know me, and for the rest to employ raw Arnhem Land natives, rendered advisable a change of plans. I was anxious especially to avoid the possibility of a clash with the natives of Arnhem Land, which would defeat the object of my work even before I had had the opportunity of establishing myself with them. The greatest care therefore was necessary in making this first approach. Finally, I decided to send the *St. Nicholas* to Groote Eylandt, where it was to remain within call of the Mission pedal wireless set, until I had made some contact with the natives. My plan was to go to Darwin and thence to approach the Caledon Bay area by an overland patrol.

After completing the loading of the *St. Nicholas* at Thursday Island, I sent her to Groote Eylandt in charge of three Torres Straits Islanders—two of whom were to return immediately—and travelled by steamer to Darwin. On arrival there I found that the *Maree*, the store vessel of the Methodist Mission at Milingimbi in the Crocodile Islands, on which I had arranged to travel out to Arnhem Land preparatory to starting on my overland patrol, was held up indefinitely through engine trouble. Weeks had already elapsed since I left Melbourne, and as I was unwilling to risk any further delay, I signalled to Groote Eylandt instructing the *St. Nicholas* to sail for the Roper river and to meet me there. My visit to Darwin was, however, not altogether in vain, for I visited Fanny Bay Gaol and made friends with the three natives—Natjialma, Mau and Ngarkaiya—sons of the renowned Old Wongo of Caledon Bay (plate facing p. 154). These three men had been sentenced to death for the killing of Japanese at Caledon Bay in 1933 but the sentences had been commuted to life imprisonment. When I left Darwin I carried with me a message stick and an oral message from these three brothers for their father, 500 miles away in Arnhem Land. This was the first step towards securing the liberation of these natives who were sent home in my custody just a year later.

At the end of May I left Darwin for Mataranka en route for the Roper, and reached the Roper Bar Police Station on June 1. The *St. Nicholas* had not yet arrived in the river; and because the pedal wireless set at the police station was out of order, it was not possible to communicate with Groote Eylandt direct. Several days elapsed with no news of the vessel. The police depot at the Roper Bar is about 100 miles from the mouth of the river, above the junction of the Hodgson and Wilton rivers, and in the meantime I moved to the mission station about 20 miles downstream, transporting my gear in canoes. Several more days elapsed without any news of the vessel, and as the Roper is strongly tidal and the vessel was under sail alone I decided to go down to meet her. I obtained the loan of a small dinghy into which I loaded the cameras and more valuable items of scientific equipment, and with three native canoes to carry the heavy stores and gear, set off down the river.

It was a memorable journey. The wooden canoes of Arnhem Land, called *lippa lippa*, are all built on the same lines; they have a rounded bottom (with no keel whatever) and no outrigger, and unless very carefully loaded, trimmed and handled, are easily upset. These canoes are a legacy from the old Malay or Macassar voyagers who came each year in season for pearls, *béche-de-mer* or trepang. Each prau brought eight or ten canoes which served as tenders for the trepang fishing, and when the praus were about to return home the canoes, with other presents, were generally given to the natives in whose territories the praus had been operating. On the voyage down the Roper the canoes had to be bailed constantly and beached at frequent intervals, so that it required constant vigilance to keep the little convoy together. No sooner would we get under way after a halt than someone would sight a water "goanna" or monitor lizard (*Varanus*) sunning himself on a mangrove limb overhanging the water. Our paddlers would exercise a deft manoeuvre—almost precipitating disaster to a canoe with only a few

inches of freeboard—to swing our canoe backwards and so give full scope to the bowman in the leading canoe; standing up now, tense and rigid, with spear poised awaiting his opportunity when the quarry came within range. It was useless to protest. Food was plentiful, and at the wayside camps we employed our time in hunting geese, ducks, wallabies and kangaroos. Crocodiles were also numerous and were seen frequently on the Roper. When I went down the bank of the river to drink, one of the natives would stand behind, throwing a log or branch into the water in front of me to frighten away reptiles that might be lurking near. The natives from long experience are much more careful in these matters than the white man, for although deaths from crocodiles are not frequent, almost every river has its record of victims.

On the night of June 9, shortly after we had made camp after a long day of paddling, the *St. Nicholas* appeared around a bend of the river. Early the following morning we loaded all our equipment aboard, took the vessel down to the mouth of the river, and anchored in the estuary off a large native camp. This camp consisted at that time chiefly of members of the Nunguboiyu tribe with a few natives from the Wanderang, Mara, Yukul, Ngandi and other tribes of the Roper river area. The Nunguboiyu, generally known as the Rose River tribe, is still numerically a strong group whose territory is situated to the northward of the mouth of the Roper, extending from the mouth of the Phelp river to Cape Barrow on Bennet Bay which lies at the southern end of Blue Mud Bay. There were about eighty or ninety natives in the camp; they had gathered in preparation for a ceremony and were subsisting by dugong fishing in the Limmen Bight to the south of the mouth of the Roper river.

Kapiu, the Torres Straits Island native who had brought the *St. Nicholas* from Groote Eylandt, had secured from Bickerton Island two men of the Ingura (Groote Eylandt) tribe. And at the Roper river I collected a number of natives, including a crippled boy "Smiler" who had been brought in early childhood from the northern end of Blue Mud Bay; a Nunguboiyu man named Mardi, of very powerful physique, and two or three other natives of this coast who attached themselves to our party.

On the following morning we ran out through the mouth of the Roper river northward bound. Conditions at sea were not favourable, for a south-east wind had arisen soon after daybreak and was rapidly growing in intensity. The mouth of the Roper river forms a narrow channel that threads its way through a series of sandbars and banks with shallow waters on which the yellow, discoloured seas break heavily in the south-east season. These banks extend for about 5 miles into the sea towards Maria Island. By 1 p.m. we had cleared the banks and were running northward on our course. But the wind had attained the force of a gale and off the shallow coastline the *St. Nicholas* was rolling in a heavy sea that took her on the beam.

The only possibility of shelter now lay in making for Edward Island off the mouth of the Phelp river, a little to the north of the Roper. The waters here are quite uncharted, the island is surrounded by shoals, and owing to the rough sea the water was yellow and discoloured. We were obliged to feel our way inshore with the leadline, making for the best shelter available, and

at length dropped anchor on the south-west side of the island in 2½ fathoms of water. On the following morning the wind increased in velocity and, as these conditions appeared to have set in and seemed likely to last for some days, I decided to employ the time in making a reconnaissance on foot to locate the main camps and to make contact with the natives between the Phelp river and Cape Barrow, away to the northward, leaving the *St. Nicholas* to follow as soon as the weather had moderated sufficiently.

Taking two natives, a man from the Roper river and Mardi the Nunguboiyu (Rose river) native, I set out early on the afternoon of Wednesday June 12. We landed on the north bank of the Phelp river, prepared for a journey of three or four days which I calculated would easily take us to Bennet Bay. To travel light we cut our loads down to the bare minimum. I carried a single blanket with a sheet of Birkmyre canvas, a tomahawk, a few short lengths of heavy-gauge fencing wire for fish spears, a shot gun and a few cartridges, about 20 lb. of flour, a small piece of bacon, a little tea and sugar, and tobacco for the natives. I wore, instead of boots, only a light pair of sandshoes without socks, and shorts and shirt. We expected to reach Bennet Bay by Saturday night. Mardi knew the country well, having travelled with his horde [1] in its seasonal movements up and down the coast from the mouth of the Roper river to the Rose river and Bennet Bay. We planned to follow the coast and to reach the mouth of the Rose river that same night; to cross by native canoe in the morning, and thence to strike northwards to Bennet Bay.

We walked hard all through that afternoon and into the night, traversing miles of flat, dry salt pans fringing the coastline, and late that night in the moonlight we reached the wide estuary of the Rose. Although the mouth of the Rose river appears on the charts with a single channel, a small island or delta lies at the entrance, to which I have given the name Mardi Island. The natives were insistent in their desire to cross over to an old camp site on the delta at the mouth of the river. We were able to reach this island at dead low water by walking out across the sandbanks, wading the intervening channels and threading our way through the banks of soft treacherous mud, possible even in daylight only to one possessing intimate local knowledge. The island was surrounded by dense mangroves and we camped on an open sandspit on the seaward side where the wind from the sea drove the mosquitoes away. The boys went off in search of water and by excavating a disused native well eventually obtained a small quantity; but it was very foul with a fetid smell

[1] The name "horde" is applied to the local nomadic group which occupies a given clan territory. Although the Nunguboiyu has the status of a tribe, tribal organization is absent from north-eastern Arnhem Land, where the unit of social life is the "clan." The clan is the land-owning group. Each group is nomadic within the confines of its own territory, and sometimes in the territory of certain other clans, over which it exercises special hunting rights. As these people are patrilineal, and as the clans are exogamous (the women of the clan marrying into other clans and the men marrying women from other clans), the group which occupies a given clan territory actually consists of members of several clans. For this group the name "horde" is used. As will be seen, the horde in Arnhem Land is an independent, self-governing unit. It is also the war-making group, and the fighting which rages constantly is between hordes, either singly or in groups united chiefly by affinity within the kinship organization.

of Caledon Bay

Hinterland, Blue Mud Bay

and taste. Much of the water in these deep wells on which the natives of the coastal areas depend, and which we had often to drink, was of this character—stagnant and smelling evilly from the decaying vegetable matter with which it was impregnated, and just brackish enough to be nauseating.

The night was bitterly cold with a keen wind off the water, and although we were all dead tired, we slept only fitfully. I awakened the boys early; they made up the fire and squatted over it like two lizards basking in the sun. The tide was now high and the island was isolated from either shore by a wide span of water. To the north lay the main course of the Rose river, which was here from half to three-quarters of a mile wide with a deep channel in midstream. The southern channel, which we had crossed the previous night to reach the island, was obscured from view by a dense wall of mangroves.

There was no sign of a native camp. Mardi had "thawed" a little and went off in search of dry logs and driftwood. He returned with two or three of these and bound them together with the creeping stems of *Ipomea pes-caprae* —a plant with a wide distribution on tropical beaches, that sends its sprawling vines abundantly over the sandhills. Then, carrying this crude swimming raft into the water and clinging to one end of it so that it supported part of the weight of his body, he swam across the wide estuary. At this season of the year the water is extremely cold and the natives suffer severely if they are in the water for long.

Meanwhile the Roper native lay prostrate with a heavy "cold sick"—a condition which affects these natives frequently at this season of the year. It comes upon them quite suddenly; the night before the boy had been quite normal, but all through this morning he lay face down on the sand. He was quite unfit to work and too morose to speak except in monosyllables. Quite suddenly he had completely lost interest in everything and for hours lay as if he were dead.

Early in the afternoon Mardi returned alone the way he had come—swimming with his log raft. He reported that the camp was deserted. The tracks indicated that the natives had all moved north to Cape Barrow on Bennet Bay. Subsequent events proved that he was right, but the discovery very nearly cost two of us our lives. Mardi emerged from the water after his long swim, cold and sullen. He had been so certain that there were natives here who would accompany us north. I gave him food and tobacco and turned to make some hot tea. I put aside the billy for the two boys, and then it occurred to me suddenly that I had not seen them for some time. I turned to look for them. They were nowhere to be seen. I knew at once that something was amiss. I went first, however, to see if they were searching for better water or if they were out on the flats looking for a crossing—for it was evident that we should all have to swim. But there was no sign of them. At length I met the Roper boy alone—coming back to tell me that Mardi had run away. He had suddenly gathered his possessions, dived into the dense mangroves and swum across the south channel of the river. Already he was on his way back to the camp at the mouth of the Roper river.

I sat down and took stock of the situation. I was stranded on an island, separated by about half a mile of water from the north shore, with a native whom I did not know—a native who was not only too sick to travel or to hunt,

but who did not even profess to know the country between us and Bennet Bay where the boat would be waiting for us. He had made one trip there—but that was more than twenty-five years before when, as a boy, he had been sent to muster men for the ceremony at which he was to be initiated. We had no reserve stores, almost no water, and the *St. Nicholas* would certainly have sailed northwards out to sea so that we should not be able to signal her. I was anxious to get away from the island and to find good water, but the native had thrown himself down on the sand again and for hours I could get no response from him. Late in the afternoon he seemed to get a little better and began to take an interest in life.

Our first object was to get clear of the island and to find water. While we were waiting for the tide to fall, we searched the island for stones with which to sharpen the wire that I had brought to convert it into a fish spear which would be a valuable implement for getting food on the journey ahead. We found only a single large stone. But this served as an anvil and we used the tomahawk to draw out the wires, and then ground the points by rubbing them on the stone. We could mount them later, as soon as we found a suitable shaft.

It was now late afternoon and as the tide, which had turned some time ago, was now falling rapidly, we made ready our loads and prepared to leave the island. We did not know the country ahead, nor whether we should find water easily or if it would be necessary to make a long journey up the river in search of it. There is a very great length of coastline and although there is abundant water inland, the natives living on the coast depend chiefly on deep wells, some of which are very old. These wells are few and far between and it needs local knowledge to find them.

The boy took the loads on his head, turned north and waded out across the mouth of the river, hoping to find it sufficiently shallow there to enable us to ford across to the sandbanks, leaving only the comparatively narrow main channel to swim. But at a distance of only 20 yards from the shore he was up to his armpits with half a mile still to go, and he had not yet reached the deep channel. Night was approaching, it was already bitterly cold with a keen south-east wind, there was a strong tide, and I was unwilling to risk the long swim under these conditions in a place that we knew to be infested with crocodiles and sharks. I called the boy back and abandoned the idea of crossing the north (main) channel of the Rose river. By wading from bank to bank we eventually retraced our steps to the south bank of the river which we reached before dark. Our first objective now was to find fresh water and, on the following day, a place to ford the Rose river without having to waste energy by travelling far inland.

We set a course westward, and by moon and starlight we walked for many hours that night. At a little distance from the estuary we crossed the tracks of Mardi, making south towards the mouths of the Phelp and Roper rivers. The low-lying salt pans near the coast had been flooded recently and were reduced to a great expanse of deep sticky grey mud in which we sank at every step. It was heavy going. Again we crossed miles of salt pans interspersed with ridges of slightly higher ground clothed with low xerophilous scrub, very dense and prickly, which tore our clothes and scratched us severely. Very

late, just as we were about to abandon for the night the search for water, we ran into a series of low rocky outcrops and following up a dry gulch we found a fair pool of water, slightly brackish but better than the dirty and fetid-smelling water in the well that we had left on the delta some hours before. We made camp close to the pool, on hard reddish ironstone ground. We were astir early, boiled the billy in the dark and set off again as soon as it was light enough to see at all.

The journey northward, for which we had originally allowed a bare four days, occupied eight—eight long heart-breaking days—and was nearly a disaster. For the most part I shall depend upon extracts from my journal, made during the journey, to tell the story.

"Friday 14th. Fair night, not so cold as last night; awoke very early, made up big fire and wrote this journal.

"Hope, but do not really expect, to cross the Rose River to-day; the boy says it is deep and infested with crocodiles, so we shall have to go far up. Living on black tea, dry damper with an occasional slice of bacon.

"Miles of arid salt pans interspersed with sandy or gravelly ridges, sometimes with heavy outcrops of stone. Camped eventually on a chain of lagoons to the north of the Rose River mouth but still on the south bank, after one of the hardest and most gruelling days of my life. On the south side of the river we saw much 'Cyprus pine' (*Callitris*) from a few inches to about a foot in diameter; many fine wattles, and a splendid shrub known as the 'Turpentine bush' (*Calythrix microphylla*)—a blaze of rich purplish hue like heather."

We left camp on the following morning soon after 6 a.m. and walked steadily. The boy did not complain of "cold sick" to-day but of his tired legs and aching back. After about two hours' travelling the river began to narrow and we saw two or three places where it looked possible to cross. Keeping an eye open for dry Pandanus or other material for a raft or swimming log, we watched for the most suitable spot. Fortune favoured us and soon we came upon an outcrop of stone dipping steeply to form a ridge right across the river, parts of which projected above the water. At these fords, however, caution is necessary for crocodiles are in the habit of watching such places for dingos, kangaroos and other prey. Soon after nine—about three hours after breaking camp—we were safely across. As we did not know the country now that our guide had deserted, and as our stores were short, I decided to make for the coast again and so set a course east-north-east. The country was rough and stony and after we left the river, water was very scarce again. Although at this season of the year the nights were cold, it was intensely hot all day and I learned much about the occurrence of water and the natives' methods of getting it. When we were very hard pressed we tapped the great nodular swellings on *Melaleuca* trees which sometimes provide a little water—though bitter and highly mineralized. That night we had a fairly comfortable camp with abundant water.

On the following morning, the fourth day, we set off again after daylight. The boy talked constantly of a "Lake Mary" which he described as a great camping place where he hoped to find natives. No recent tracks were seen and we skirted the lake without sighting the camp, then struck east to return to the beach where travel would be less severe. After some hours of walking

we caught a glimpse of sand dunes and knew that we were approaching the coast at last. In the early part of the morning we passed within a few feet of the finest specimen of *Pseudechis australis*, the King Brown Snake,[1] that I have seen alive. This is one of the largest and most aggressive of the venomous snakes of northern tropical Australia. He was sunning himself at the foot of a termite mound, a fine showy snake, rich copper-brown in colour, about 7 feet long and very thick and heavy. When we passed he reared his head high in the air, flattened his neck and lashed his body about from side to side, his orange-red eyes gleaming wickedly.

We steered east towards the sandhills. My left thigh and calf were now sore and swollen, and I had a big hard swelling behind my left knee that made every step an effort. Just before we reached the sand dunes the country opened out into a wide plain on which were several lagoons and marshes, all salt. Wading birds were numerous and the boy took the gun and went ahead to stalk a Plain Turkey or a Jabiru which we saw feeding; but the birds proved too wary.

Our spirits had risen when we saw the white tops of the sandhills gleaming in the distance and we struggled on, expecting to look down on the sea again from the top of the dunes. When we climbed the first sandhill we were dismayed to see that this was but the outer tier of a series and to find ourselves confronted with lines of similar hills, the lower slopes and foothills between covered with dense, almost impenetrable thickets of spiny, prickly shrubs and tangles of creeper. We rested a little; then we started to fight our way painfully through the dense tangles, sometimes erect, sometimes crawling on hands and knees. We had nothing with which to cut the tough, yielding, spiny brushwood. The sweat streamed down our faces. I called a halt again and we tried to fire the scrub. But it was still green and would not burn readily. At last, after what seemed hours, we arrived torn and bleeding and utterly exhausted on the open sandhills and looked out across the empty sea. But luck was with us, for just at this spot there was a group of she oaks and a soak with fair water. We limped to the trees and gratefully threw ourselves down in the shade. A glance southward showed us something familiar about the headland near the sandhills that we had just crossed. We were once more close to the mouth of the Rose river—only a few miles from the delta we had left three days before.

My journal reads: "Made tea and damper. Made another damper to conserve water later and also because the boy is now so weary that he cannot yet be persuaded to go on. He now throws down his load repeatedly and says that he must rest. Got him away again early in the afternoon, but he was tired out.

"After what seemed another long walk, but when in reality we had covered only a mile or two, we camped on a small but deep creek where there was a dugout canoe moored on the far side. The boy swam over, fetched the canoe

[1] During the course of these expeditions much zoological work was carried out and more than two hundred snakes were collected. These included many venomous species from which the poison was extracted for later research on its toxicity, and also to determine the weight of venom yielded under natural conditions. Several specimens, nearly 8 feet long, of this large snake known to the natives as *darpa*, were secured alive and their venom extracted in the field at weekly intervals.

and ferried me across. Paddles, dugong rope and all the paraphernalia of the dugong hunter were placed for safety in a tree at the mooring place, and there we found also a deep little well scooped out of the shell bed.

"Decided to camp, partly because we were exhausted and partly because the boy discovered a mark which he declared indicated that the owners of the canoe were not far away, so that it was probable that they would come if we made a fire. . . . The boy says that he will sail the canoe up tomorrow if the owner does not come along this evening. We burned the only grass that was dry enough and set fire to a patch of dry scrub near the beach, but it did not burn well and made very little smoke.

"We went upstream with the canoe and got firewood, also collected hermit crabs and oysters. Hermit crabs bitter, but the oysters good though small. Cooked them blackfellow fashion, the mangrove roots to which they were attached cut off and roasted whole.

"We made a fish spear this afternoon, but throwing it at a fish from the canoe, it was carried away, the boy says because he speared the fish in the body and not in the head or neck. Tonight he made another spear with the remainder of the wire—a much better effort with a lighter handle.

"The boy was uneasy and during the night as we were sitting by the fire he cried out at intervals in a loud voice his name and that of the country he had come from. It was the natives' custom, he explained, to prowl around the camp and to attack without warning, but if they knew who he was and what he was doing, it would set their minds at rest.[1]

"This may also account for what transpired about the canoe. He had undertaken to sail it north, but late at night he cried out that he was a fool and that he had forgotten to take the canoe and moor it out before the tide fell, and asked me, not very convincingly, to wake him up. I did so but he said that there was too much wind and sea and that the canoe would be broken up. . . . As he was very dour and sullen there was nothing to be done, but I guessed that he was afraid to take it. We had agreed to leave tobacco for the owner and later to return it. Bad night. At 3.30 a.m. I gave up trying to sleep and boiled a billy of water and bathed my swollen and painful left leg. Soon after 6.0 we left camp and pushed on northward.

"We followed the beach for a short distance and then struck across a headland where the boy believed there was a short cut, but we found our way barred with a dense wall of mangroves. For several hours we struggled through dense thickets; sometimes of dense mangroves, sometimes of dry salt-water scrub. It was impossible to see out, or to tell what progress we were making or where the direction we were following was leading us.

"After a long, desperate struggle through this tangle—very painful for both of us—we found our way barred by a wide creek or inlet, its deep green water fringed with a wall of mangroves. We climbed up into these and saw that this barrier extended away to the northward and to the westward. We passed for two terrible hours through scrub so dense that part of it had once more to be traversed on hands and knees. I felt despair very near that morning. . . .

[1] During the next few months, when I was travelling in country that the natives regarded as hostile, this custom became familiar.

"At intervals we climbed trees to see how the land lay, but the trees were all too small and gave us a view only of a sea of dense, seemingly impenetrable thickets. At length I decided to strike west, and climbed a low hill to survey the country. We saw the mangrove-fringed river swing away to the west and beside it lay wide, open salt pans. There was still a long stretch of dense undergrowth to traverse. But we knew our direction, we knew now, at last, where we were heading. Rough stones, weathered to a series of sharp points and partly covered with long grass, outcropped on the low intervening hills and cut our feet badly—for I, too, had been barefooted since the previous morning."

When we emerged on the plains we noted native tracks, all heading north and all converging in one direction. They became so numerous that we followed them and at length reached a point at which they disappeared into the river. This proved to be a ford and we crossed the river in water just up to our armpits. A hard struggle followed, again through dense wattle and prickly xerophilous scrub that further lacerated my bare legs and feet, but we were rewarded at last by striking the beach at a point where there was a fine native well. We filled a water bag, boiled a billy, and also made a damper to conserve the water that we carried. The tide was falling and we made the best time we could northward to cross the Hart river, a creek just to the south of the Minnie river. At this creek we secured a Burdekin duck and two silver gulls and halted to cook them. To the boy's great disgust I ate the livers of the gulls raw, and of anything else we killed, to offset the effect of the diet of black tea and dry damper. We had crossed the Hart about 5 o'clock and reached the Minnie itself just after dark, clouds obscuring the moon.

The struggle of these days, the effort to keep going and to keep the boy from giving up, will live with me for a long time. I remember how on this and the succeeding two days we dared not look far ahead at a distant landmark; the effort that we knew would be needed to reach it seemed more than we could stand. Instead, we fixed our eyes on a tree or something on the beach and concentrated only on reaching that. My journal of that day, written at the Minnie, reads:

"For the last few miles I was so tired and in such pain that I felt half anaesthetic to the touch of the sand. I had great blisters on the soles of both feet —the one on the left much worse than the one on the right. These had burst and were giving me serious pain, and I found that the blisters were packed full with sand. Cleaned them out by removing the skin and tied my feet with some old rag I had had for cleaning the gun. Lay down aching and very cold.

"The boy made a half-hearted attempt to find a crossing, then we huddled under the lee of a great rock and made a little fire; we were far too spent to do much foraging for firewood. The boy had told me that the river was knee deep, now he reported that the tide was not low enough. I woke him again later—but the tide had turned and was then running in; it was too late to cross. A day lost; all this day's effort seemed to be in vain. Had to sleep. Cold, stormy, overcast night with high wind; breakers booming all night.

"June 17th. Am writing this after the worst day yet. The boy announced that we could not cross here but that we had better go up and around the

Minnie. Tide high now and rising. The boy also says that he believes that there is a tributary on the south of the Minnie that winds for a long way westwards. Painful to stand on my feet, much less to walk. Struck native tracks and followed them south-west through sandhills and found good water near a tributary creek about a mile back from the mouth. Decided that we could cross here, and we settled down to wait all day for the tide to fall. To-day, the last two or three teaspoonfuls of sugar that I had kept are finished; did not use it yesterday but held it over. Cooked a damper and tried to make a raft—at least the boy did; I could give little help as I can only walk with difficulty. Shot a Bar-shouldered Dove and had a few mouthfuls each—our only fresh meat for the day—and a little bacon. Went to inspect the mouth of the river. At the mouth saw a crocodile just slide into the water as we got there and it seemed the last straw. . . . Decided to push on up the river and try to get over. We laboured along a native pad over terrible country for what was probably only two or two and a half miles, and then climbed a tree and saw that after all the river ran south more and more and broadened into a wide maze of mangroves. Decided, to the boy's disgust, to return to the mouth and try to cross that way. He says it is dangerous; the alternative —miles of travel by night to cross the Minnie or get around it—to me, barefooted and scarcely able to walk, impossible." We decided to wait till nightfall, when the tide would be low. "Tiger (my Kangaroo dog) very emaciated and coat staring, but still game. . . . If we get over tonight I shall be more free with the cartridges."

The hours of waiting seemed an eternity. The boy collected a bundle of dry branches and lashed them together with strips of bark. The tide fell very slowly. It was late at night, the moon obscured by clouds, and bitterly cold. Just as we were ready a shadow seemed to pass in the water; we waited, but in the dark depths there was nothing to be seen. After a little while we went on. Pluckily, the boy made a crossing first, reached a sandbank and stuck a fish spear there; then, with the aid of the rough raft on which I laid my swag, I crossed to the sandbank. With my stiff and swollen leg I was not much use for swimming. The boy made another journey and this time Tiger swam too.

We landed on the outer fringe of a dense tangle of mangroves, muddy underneath, with high roots like stilts and of an impenetrable blackness. We climbed on top of this tangle of roots and groped our way through fetid ooze and a confusion of roots. When we reached the other side the boy was exhausted and his teeth were chattering violently. We walked across the open plain on the fringe of the mangroves to the edge of a strip of scrub, made a fire, and lay down.

Before daylight in the morning—the seventh day of the journey to Bennet Bay—we were away again, making north. We returned to the beach and the going was not at all bad. Ordinarily it would have been reckoned easy walking, but we were very weak from long travel and from want of food and rest. My greatest trouble that day was to keep the boy going; he wanted to give up and lie down. He asked me to leave him to die. Always in my mind and spurring me on was the worry lest Kapiu, the Torres Straits Islander in charge of the boat, might become anxious and I was afraid that he might then

sail for Groote Eylandt, where there was a wireless set, to ask for help. This would have meant defeat for me, a disaster far worse than anything that could have happened on the journey.

I cannot describe adequately that journey. We were both by this time in a desperate state; the pain of the sand on our now skinned and lacerated feet and swollen legs brought a feeling of numbness and of intense cold. There was about us a vast space that seemed suddenly to have closed in like a material, substantial thing. It was as if at each step we had to force our way through a solid nothingness. So had the sense of unreality become fantastic.

The boy had long since abandoned his blanket. I tore mine up now to make bandages for my feet; but these filled with sand which added to the pain of the wounds and after many attempts had to be abandoned. After a while, we did not talk much. Our pace was reduced to little more than a crawl. The boy insisted on lying down at frequent intervals, but for me these halts only made matters worse. Before the day was out we had some difficulty in getting on to our feet after a rest, and the pain of walking was intensified by each halt. We walked as close to the water's edge as possible, for the sand was harder there and progress less painful. But it was an intense effort even to move up the width of the beach. Early that morning I noticed what appeared to be a dead turtle at the water's edge, so shrunken and emaciated that it seemed at first to have been long dead. It proved to be a small green turtle, thrown up on the beach in the storms of the past week, injured too badly to regain the water but still alive. It provided us with a little meat which we needed badly, very pale in colour for it had little blood; almost like fish. A little later in the morning we saw turtle tracks across the beach and found a nest of fresh eggs. We dug these out, broke the soft parchment-like shells, and greedily swallowed some of them raw. The remainder we carried.

Early in the day we came abreast of Bickerton Island which lies between Groote Eylandt and Cape Barrow at the head of Bennet Bay. But by nightfall, after a full day's walk, we had made such little progress that we were still miles from Cape Barrow. This was the worst day of the journey. The boy lay down at frequent intervals and when I tried to get him on to his feet he begged me to leave him behind. I knew that we could not now be far from Bennet Bay. If I could find water we could live for several days on the turtle eggs. During the day we saw native tracks, still fresh. They were still moving northward, but the tracks were obviously recent and indicated that the natives had passed since the storm and therefore that they were not far ahead of us. Towards nightfall we reached an old camping place which my companion remembered having touched previously in a boat that put in for water.

We found two lagoons in both of which there were water lilies, and close to one of these lagoons we made camp. The water lilies meant food in emergency, for the seed capsules and the rootstock form an important part of the diet of the natives. But the boy was now too spent and too cold to swim for them. Here we boiled the last morsel of bacon that we had cherished, carefully conserving the liquid in which it had been boiled in order to cook the pieces of turtle meat that we had carried since morning. This, with as many turtle eggs as we could eat, made the best meal that we had had since leaving the vessel. Another cold night followed.

On the following morning, June 19, we were much refreshed. But the boy was very weak and I was now suffering so much pain from my feet and legs that I could stand only with difficulty. It was impossible for us to carry our loads if we were to make any progress. Before leaving camp we dug a hole and buried most of the remaining turtle eggs to preserve them in case of need. My remaining possessions, a sheet of canvas and the tomahawk, we also abandoned, placing them in a tree close to where we had slept. We were now a little to the south of Cape Barrow, and leaving the beach here, we turned west and set a course for the north of Bennet Bay where the *St. Nicholas* should be waiting for us. We knew that she should not be far off; or, failing the boat, we should find a native camp. But although we again started early, we made little progress and after several hours we had covered only a short distance. During the morning we saw smoke and evidence of recent fires and we burned what dry vegetation we could, hoping to attract the attention of hunting parties that might be about. Much of the skin had now gone from the soles of my feet. Stones, sticks and sharp grass stems made the journey a painful ordeal. I sat down and again bandaged my feet to protect them with the remaining rags of blanket. But during the morning we had to wade through a wide, shallow swamp area, and the clumsy bandages dragged so that I could scarcely lift my feet and they had to be abandoned.

Early in the afternoon we came out on a grassy plain and thence emerged on a salt pan. In the distance a green wall of mangroves marked the vicinity of salt water. A little later we sighted what appeared to be a group of natives. But this was no mirage or vision that mocked at us. The natives proved to be men of the Nunguboiyu tribe, members of the group whose tracks we had been crossing from time to time during the past week, then always moving in a northerly direction. I remember the sight of those figures and how they affected us as if it were yesterday: the sight of other human beings. Only eight days had elapsed, but there are occasions when time cannot be measured. A mist shimmered before me, a dry lump rose in my throat and I had to swallow hard. We could not relax at once. I know that I could not talk. There was the need to retain control and to present outwardly only a mask of indifference. I remember our formal greeting. It was as if they were old friends from whom we had been parted only a few hours. I know that I must have seemed unfriendly, even callous, for I could not trust myself to speak.

The natives whom we had met guided us to the *St. Nicholas* which lay at anchor close at hand in Bennet Bay. Later they went back over our tracks to pick up the gear that we had abandoned at our last camp.

There was a big camp of the Nunguboiyu tribe on the eastern shores of Bennet Bay at this season, numbering approximately one hundred natives—men, women and children. They had concentrated in this sheltered place following the stormy weather that had prevailed for some weeks past, and were engaged in dugong and turtle hunting and in fishing. They were a happy, friendly people. Most of them had already made contact with white men at trepang camps or in the camp at the mouth of the Roper, or they had made visits to the missions at Groote Eylandt and the Roper. They hunted and fished industriously and each morning, soon after sunrise, a fleet of five or

more canoes would set out from camp for the fishing grounds a mile or two off shore. Besides dugong and turtle, fish and game were plentiful and the natives were in splendid condition, well fed and happy. Children, who are conspicuous by their absence in civilized conditions, were numerous in this camp.

During my absence from the boat, the two Bickerton Island natives whom Kapiu had taken to the Roper on the *St. Nicholas*, had deserted when the ship reached Bickerton where the boat had put in for water on the journey north. This desertion had left only the crippled boy "Smiler," who later proved to be suffering from nodular leprosy in an advanced form, and a bush boy Marrilyauwi to assist in bringing the boat to Bennet Bay, so that Kapiu had run the ship almost single handed despite the rough weather. When we reached the *St. Nicholas* I gave Kapiu one instruction which he was never to forget. No matter what happened, or how long I might be delayed on any later patrol, he was never to ask for help. And although he had many anxious times, he never forgot.[1]

We remained at this camp for two days in order to make friends with the people and to have a short rest before proceeding with the most important part of my mission. Both the native who had accompanied me and I myself were suffering severely from our injuries. For several days I was scarcely able to stand but had to content myself with crawling about the deck on hands and knees. At the time of our arrival the camp had been situated on a rocky part of the shore, strewn with boulders and stones covered with oysters. But to enable me to visit them, the people moved their camp a little distance along the coast to a sandy beach which I could reach easily in the dinghy from which the natives carried me ashore.

The "dry" or south-east monsoon season was now well advanced and I was anxious to proceed with the real objective of my expedition—to locate and make contact with the people of Blue Mud Bay who had been responsible for the deaths of the three white men in 1933.

[1] Kapiu, a full-blooded native of Badu Island, Torres Straits, was with me throughout the first and most difficult part of the work in Arnhem Land. Later, during the war, a fully enlisted soldier with the rank of Sergeant in the Australian Military Forces, he served with me as bosun on the armed patrol vessel *Aroetta* in Arnhem Land waters and in the Arafura Sea. In 1943 he accompanied me in Dutch New Guinea on a hazardous patrol behind the Japanese lines, where he was wounded in action with Japanese-armed natives. He proved himself throughout a loyal and faithful companion and a fine soldier.

(*To be continued*)

THE PRESENT CLIMATIC FLUCTUATION

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THE PRESENT CLIMATIC fluctuation has been discussed since the 1920's almost exclusively in scientific circles,[1] although recently it has become a subject of more than academic interest.[2] The reason for this is the increasingly obvious consequences of this climatic phenomenon on both physical and biological conditions, in Europe and elsewhere. Ordinary people are beginning to realize that something has happened and is happening which is of great interest to themselves. The last dry summer, which transformed large parts of Western Europe into a virtual steppe, increased this interest and also caused anxiety, though this drought cannot be said with any certainty to belong to the present climatic fluctuation.

One generally differentiates between climatic variation and climatic fluctuation, meaning by the former a change of climate maintained over a long period of time, by the latter a change over a shorter period.[3] Climatic variations of primary importance are exemplified by the Ice Age glaciations with inter-glacial epochs. Transitional between variations of primary importance and fluctuations we have the climatic changes which have taken place since the last pleistocene glaciation, in post-glacial and historical times.

As regards these latter climatic variations I need only say that results obtained by paleobotanical examination of Scandinavian peat bogs have taught us that throughout the Bronze Age, the Iron Age and our so-called historical times the climatic curve has risen and fallen between eras unfavourable to man and others approaching the climatic glory of the Stone Age.[4]

[1] A summary of "Some recent contributions to the study of climatic change" was published by G. Manley in *Q.J. Roy. Met. Soc.* 70 (1944) 197–220.

[2] Articles of a more popular and special kind, published by the present author, are: "Den nutida klimatfluktuationen och dess utforskande," *Norsk. Geogr. Tidsskr.*, Oslo, 12 (1948) 290–326, and "Den nutida klimatfluktuationen och Grönland," *Grønlandske Selsk. Aarsskr.*, Copenhagen, 1948, pp. 9–38.

[3] Earlier definitions of climate took no account of time, because it was supposed that climate was constant except for short periodic variations, and that the characteristic means of the climatic elements gradually became more certain as longer series of years became available for their calculation. The occurrence of the present climatic fluctuation as a secular variation has caused the "normal value" of climatology to lose its significance. At the Meteorological Conference in Warsaw in 1935 the following definitions were agreed upon: "Pour des raisons pratiques, on définiera comme climat, les conditions météorologiques moyennes pour le mois et l'année, calculées sur une période de 30 années. On définiera comme fluctuations du climat les différences entre deux moyennes calculées sur 30 années. On ne peut parler d'une variation du climat que dans le cas où cette différence dépasse une certaine valeur qui dépend de la dispersion des observations individuelles. La Conférence est d'avis que les discussions concernant les fluctuations des moyennes climatiques devront être rapportées à une période universelle et synchrone allant de 1901 à 1930. Elle recommande d'utiliser de préférence cette période lorsqu'on dresse des cartes climatographiques."

[4] L. von Post, "The prospect for pollen analysis in the study of the earth's climatic history," *New Phytologist*, 45 (1946) 193–217.

E. Granlund's studies of peat bogs in Sweden [1] have shown that there are boundary horizons, called recurrence layers, marking changes from a damper and more maritime climate to a drier and more continental one, and the reverse. At least five such horizons have been defined, the oldest from about 2300 B.C., the latest from about A.D. 1200–1300. This climatic chronology has also been proved in other parts of Scandinavia as well as in England and in the Alps. C.-G. Wenner [2] concludes that there have been changes in the climate of Newfoundland–Labrador in post-glacial time which have given rise to five similar recurrence layers in the organic deposits, and that during later post-glacial times at least, these changes in climate have had the same main features as in Scandinavia.[3]

The climatic deterioration between A.D. 1200 and 1300 is confirmed in Iceland by the known variations of the glaciers. While the country was a free state (A.D. 870–1264) the glaciers were far less extensive than in the period from about 1300 to the 1930's.[4] The present shrinkage of the glaciers is exposing districts which were cultivated by the early medieval farmers but were subsequently overridden by ice for 600 years. The same deterioration of the climate since about A.D. 1300 certainly contributed to the decline and final disappearance of the Nordic settlement in south-west Greenland. It is hardly possible that the climate of west Greenland could have been so severe when this colony was an independent society with about 300 farmsteads, 3000 people and a surprisingly large number of cattle and sheep,[5] as it was some decades ago. Results of the excavations in the cemetery on Herjolfsnes in southernmost Greenland which have given us the well-known dresses of Norsemen from about the year 1400, now exhibited in the Copenhagen National Museum, seem to me to justify the conclusion that at no time since 1400 has the climate been so favourable as it has been since the 1920's.

It may also be worth mentioning that this climatic change coincided with the Mongol invasions westward from Central Asia which gave rise to

[1] E. Granlund, "De svenska högmossarnas geologi," *Sveriges Geol. Unders. Årsbok* 26, Stockholm, 1932.

[2] C.-G. Wenner, "Pollen diagrams from Labrador. A contribution to the Quaternary geology of Newfoundland–Labrador, with comparisons between North America and Europe," *Geogr. Ann.*, Stockholm, 29 (1947) 302.

[3] O. Selling has shown in his paper "On the late Quaternary history of the Hawaiian vegetation" (B.P. Bishop. Mus. Spec. Publ., no. 39, Honolulu, 1948) that in the Hawaiian islands the general trend in the post-glacial climatological development has probably also been the same as in Scandinavia.

[4] S. Thorarinsson, "Tefrokronologiska studier på Island," *Geogr. Ann.*, 26 (1944) 147–53, 212. No reliable historical data from Scandinavia confirming this climatic deterioration have yet been critically examined. We may, however, note that in "Norges folk i middelalderen," *Nordisk kultur*, Oslo, 2 (1938) 92, and in *Tidsskr. norske Landbruk* 18 (1911) 438, O. A. Johnsen has drawn attention to the fact that the reduction in the population from the end of the thirteenth to the end of the fourteenth centuries was concurrent with a change from growing barley to growing oats and a consequent increase in the importance of cattle farming. A series of bad harvests in the first half of the fourteenth century as a result of lower temperatures may then have appreciably contributed to the disastrous effects of the Black Death.

[5] P. Nörlund, 'De gamle Nordbobygder ved Verdens Ende,' Copenhagen, 1934; J. Iversen, "Nordboernes Undergang paa Grönland i geologisk Belysning," *Grönl. Selsk. Aarssk.*, 1934–35, Copenhagen, 1935.

E. Huntington's well-known theories and all the discussions surrounding them.

In north-east Greenland there was probably a maximum extension of the glaciers in the latter part of the eighteenth or the beginning of the nineteenth century.[1] The extreme climatic conditions implied in this extension may well have been an important factor in the final disappearance of the Eskimo from that part of Greenland at about the same time.

The longest series of records of phenomena relating to climate are those of the tree-rings of *Sequoia* and other long-lived trees which are, however,

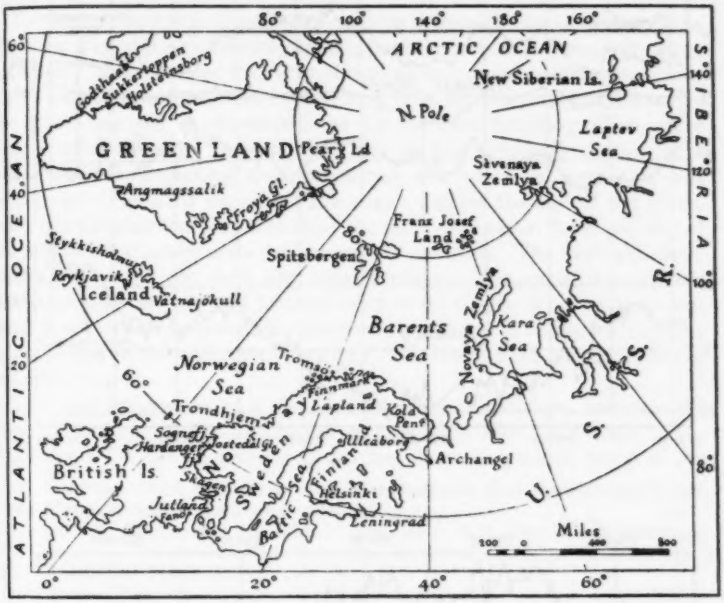


Figure 1

difficult to analyse from a climatological viewpoint. Another is that of the river Nile discharge since A.D. 622 which shows nine maxima. It is a significant fact that the maximum for about 1850 coincides with the end of an extensive advance of glaciers, a maximum precipitation in many parts of the world and the maximum tree-rings of 1860–80.

During recent decades an extensive literature has been published about the present climatic fluctuation, based on series of climatological records, and this literature is rapidly increasing in volume while the fluctuation continues and its consequences prevail. Of earlier work in Europe I will mention

[1] H. W. Ahlmann, "Studies in north-east Greenland," Part II, *Geogr. Ann.*, 23 (1941) 183–209; *idem*, "Is och hav i Arktis," *K. Svenska Vetenskapsakademiens Årsbok* 1943, pp. 327–36, Stockholm, 1944.

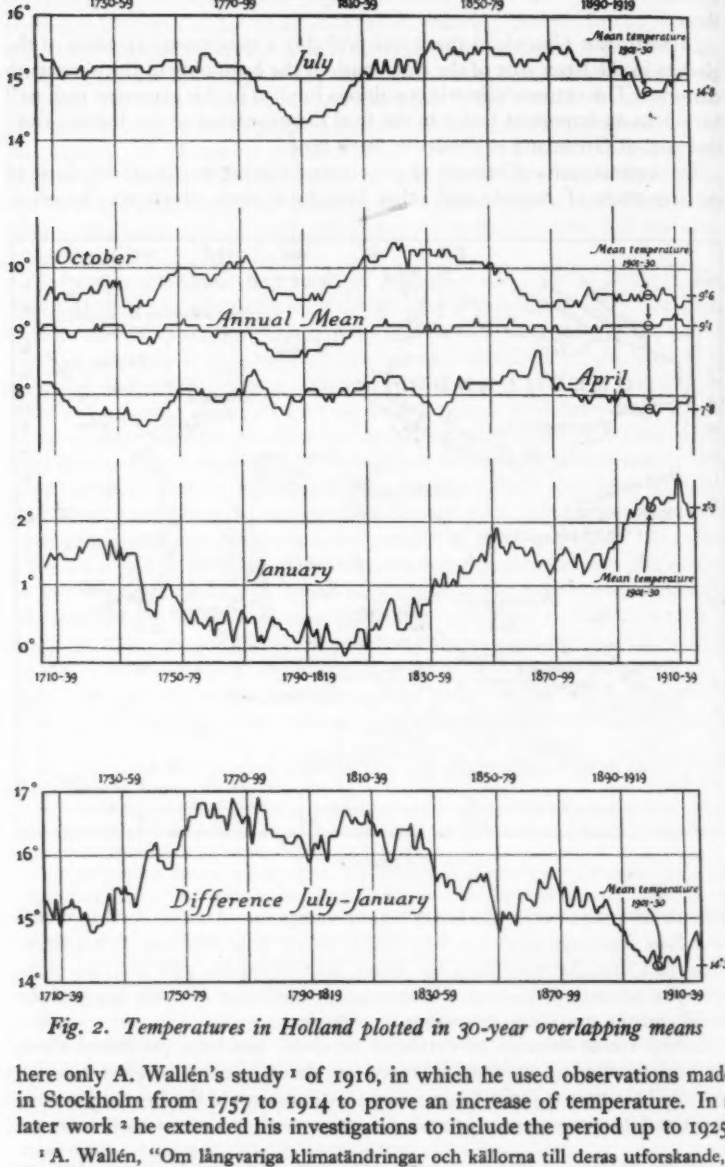


Fig. 2. Temperatures in Holland plotted in 30-year overlapping means

here only A. Wallén's study [1] of 1916, in which he used observations made in Stockholm from 1757 to 1914 to prove an increase of temperature. In a later work [2] he extended his investigations to include the period up to 1925.

[1] A. Wallén, "Om långvariga klimatändringar och källorna till deras utforskande," *Pop. Naturv. Rev.*, Stockholm, 1916, pp. 49–70.

[2] *Idem*, "Klimatet förr och nu," *Svenska Skogsv. Fören. Tidsskr.*, Stockholm, 1930, pp. 253–71.

In 1931 R. Scherhag published an article [1] about a remarkable climatic improvement in northern Europe, and later [2] found it to be of such importance in the extreme north that he introduced the expression "the warming of the Arctic." A. Wagner [3] summarized the data relating to climatic changes in general, especially those in historical times. He rejects the evidence of any regular periodicity in these changes—even Brückner's famous 35-year period—but finds on the basis of a wide range of material that the climate of Europe and adjacent areas has improved in recent times.[4]

Climatological evidence of the present fluctuation

The longest series of climatological records is from Holland and dates from the beginning of the eighteenth century, published by A. Labrijn.[5] By using his tables I have extended the curve of continuous 30-year overlapping means (or moving summations) from 1706 to 1735 (Fig. 2). For this period however the values are not so dependable as for the ones following. The winter temperatures decrease from the first half of the eighteenth century to a minimum in the beginning of the nineteenth, after which an increase prevails to our day. The hard winters of the 1940's depress the end of the curve. June and October temperatures show the same decrease in the beginning of the nineteenth century as do the January temperatures. The April and mean annual curves do not show any notable change. The curve showing the difference between July and January—that is, the degree of maritime or continental influence—is on the other hand very significant in its apparent decline from the end of the eighteenth century.[6] The recent hard winters raise the end of the curve.

The next longest series is G. Manley's from Lancashire, covering the period from 1753.[7] The Stockholm records have been used again by A. Ångström.[8] Of special interest is the fact that the general trend of the

[1] R. Scherhag, "Eine bemerkungswerte Klimaänderung über Nord-Europa," *Ann. Hydr. Mar. Meteorologie*, Hamburg, 1931, pp. 57–67.

[2] *Idem*, "Die Erwärmung der Arktis," *Ann. Hydr. Mar. Meteorologie*, Hamburg, 1939; see also L. Weickmann, 'Die erwärmung der Arktis,' *Veröff. d. Deutschen Wiss. Inst. Kopenhagen, Arktis*, Berlin, 1942, pp. 1–17.

[3] A. Wagner, "Klimaänderungen und Klimaschwankungen," *Wissenschaften*, Braunschweig, vol. 92, 1940.

[4] Among books concerning the climatic development in general, see especially C. E. P. Brooks, 'Climate through the ages,' London, 1926 (revised ed. 1949). See also Richard F. Flint, 'Glacial geology and the Pleistocene epoch,' New York and London, 1947, especially pp. 451–535; and H. V. Willett, "Long period fluctuations of the general circulation," in 'Final report of the Weather Bureau: M.I.T. extended forecasting project for the fiscal year July 1, 1946—July 1, 1947,' sect. 3, pp. 60–110, Washington, 1947.

[5] A. Labrijn, "Het klimaat van Nederland gedurende de laatste twee en een halve eeuw" (with an English summary), *Koninklijk Nederlandsch Met. Inst.*, No. 102, *Meded. Verhandelingen*, Gravenhage, 49 (1945) 1–114.

[6] See also H. Berg, "Die Kontinentalität Europas und ihre Änderung 1928–37 gegen 1888–97," *Ann. Hydrogr. Maritim. Met.*, vol. 4, 1940.

[7] G. Manley, "Temperature trends in Lancashire 1753–1945," *Q. J. R. Met. Soc.*, 72 (1946) 1–31.

[8] A. Ångström, "Lufttemperatur och temperaturanomalier i Sverige 1901–30," *Medd. Stat. met.-hydr. anstalt*, vol. 7, no. 2, Stockholm, 1938; "The change in the temperature climate in present time," *Geogr. Ann.*, 21 (1939) 119–31; "Nederbörds-

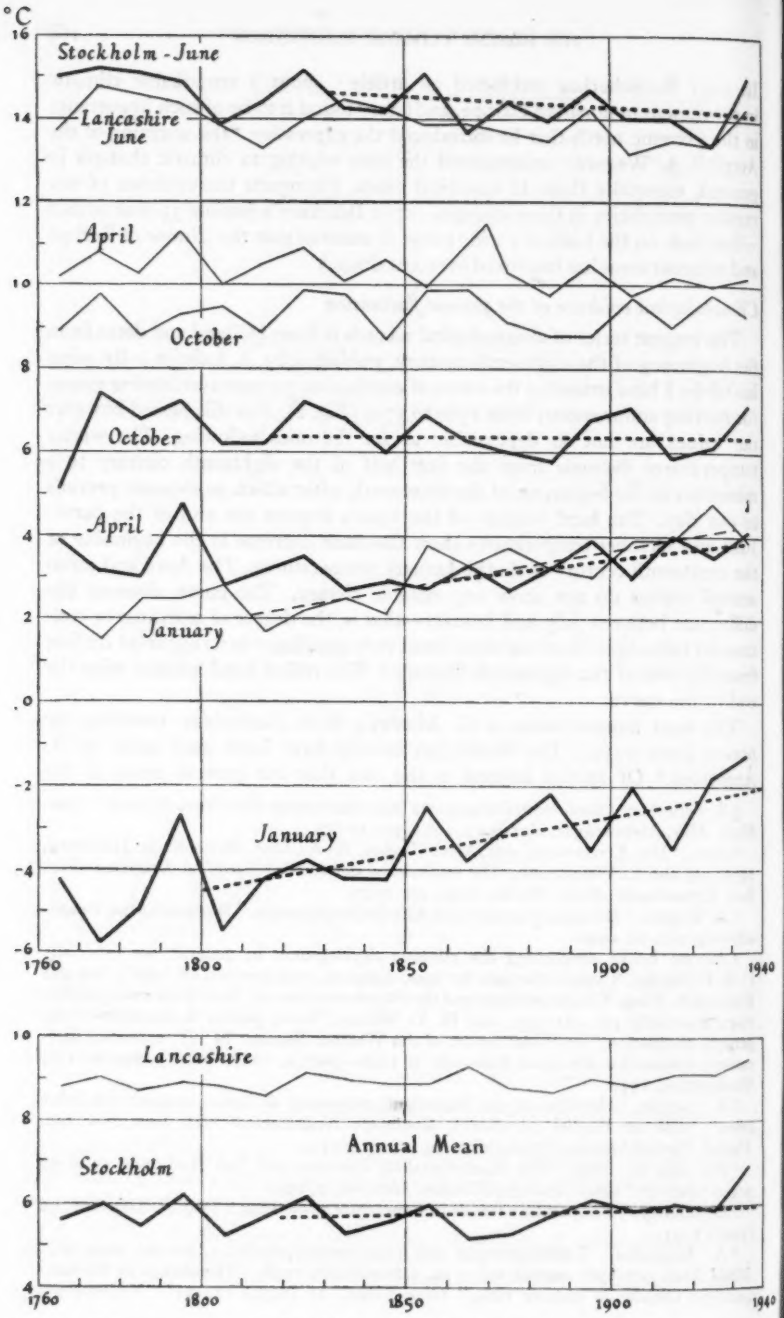


Fig 3. Temperatures at Stockholm and in Lancashire plotted in 10-year overlapping means. (After A. Ångström and G. Manley.)

Lancashire and Stockholm curves is parallel (Fig. 3). January has become about 1·7° warmer in Lancashire, 2·5° in Stockholm, and April a little over 1° warmer in Stockholm.[1] The autumn temperatures have hardly changed at all, and those for June have even fallen a little. The annual mean has risen by 0·3° in Lancashire and 0·5° in Stockholm.

Important in connection with these rising winter temperatures in Stockholm, and probably elsewhere in high northern latitudes, is the decreasing number of very severe winters.[2] The occurrence of winters when the average December–March temperatures have been more than 1° below the mean value has successively decreased in Stockholm from 13 in the period 1761–90 to 3 in the period 1911–40. The annual precipitation increased between the

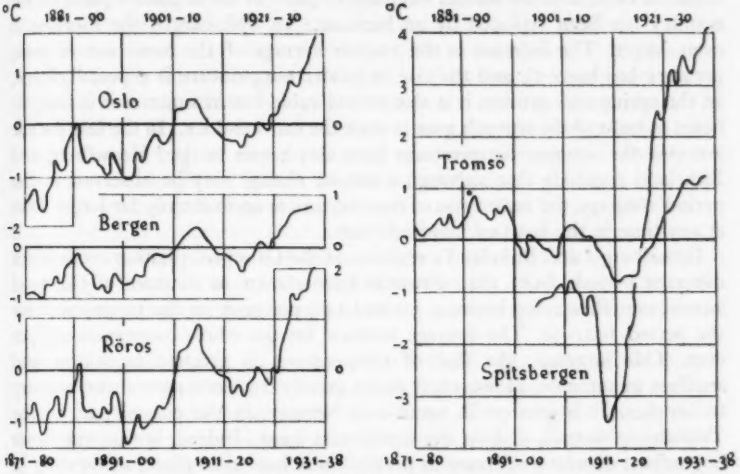


Fig. 4. Temperatures at stations in Norway and Spitsbergen plotted in 10-year overlapping means. (After T. Hesselberg and B. J. Birkeland.)

1861–1900 and 1901–30 periods by 5 per cent. in northern Sweden and by 2½ per cent. in southern Sweden.

T. Hesselberg and B. J. Birkeland [3] have made comprehensive analyses of climatological statistics from Norway for the period 1816–1938 and from Svalbard (Spitsbergen and the other arctic groups of islands belonging to Norway) for the period 1912–38, using for Norway continuous overlapping intervals of 30 years, for Svalbard of 10 years (Fig. 4). These indicate that in

klimatets ändring i nuvarande tid," *Medd. Stat. met.-hydr. anstalt, Ser. upps.* 37, Stockholm, 1941; "Temperaturklimatets ändring i nuvarande tid och dess orsak," *Ymer*, Stockholm, 59 (1939) 62–76.

[1] All temperature figures in this article are expressed in degrees Celcius.

[2] G. H. Liljequist, "The severity of the winters in Stockholm 1757–1942," *Geogr. Ann.*, 25 (1943) 81–104.

[3] T. Hesselberg and B. J. Birkeland, "Säkulare Schwankungen des Klimas von Norwegen. Teil 1, Die Lufttemperatur; Teil 2, Der Niederschlag; Teil 3, Luftdruck und Wind," *Geofys. Publ.*, Oslo, vol. 14, nos. 4–6, 1940–3.

the Oslo district the winter temperatures have increased by 1·9° since the 1836–65 interval; while the spring temperatures have increased by 1° and the autumn by 0·7° since 1859–88 and 1868–97 respectively. The summers show no distinct secular change, but a rising trend of temperature is nevertheless apparent since the period 1902–31. The mean yearly temperature for Norway has increased by 0·6°. That the climate is becoming more maritime is indicated by the fact that the difference between summer and winter temperatures has decreased by 1° since the period 1852–81. Other features of great importance are that the temperature was rising distinctly faster in the 1930's; and that the values increase inland and towards the north. North of latitude 65½°, moreover, the increase in the summer temperature began earlier than it did in Oslo, and the former decrease in June in the southern parts of the country has been replaced by an increase.[1] In Spitsbergen the increase is even larger. The increase in the 10-year average of the mean annual temperature has been 2°, and the rise in winter temperature is especially large. In the spring and autumn it is also considerable but in summer it is insignificant as most of the warmth goes to melt the snow and ice. In the last decade however the summer temperatures have also begun to rise. Hesselberg and Birkeland conclude that although a secular change may be observed in the period 1864–93, the recent rise of temperature is undoubtedly far larger than at any time in the last two hundred years.

Hesselberg's and Birkeland's revision of the Oslo precipitation records for different periods from 1840 onwards have shown an increase of the total annual rainfall varying between 3·1 and 14·9 per cent. on the mean value for the period 1901–30. The average increase for the whole country is 9·3 per cent. This increase, like that of temperature, is greatest in winter and smallest in summer. However, it varies greatly from one part of the country to another. It is greatest in south-east Norway, in the coastal part of the Trondhjem district, and on the north-west coast. Indeed, within the inner Sognefjord district a decrease in precipitation has taken place, amounting in winter to 10 per cent. between the periods 1896–1905 and 1929–38. This distribution agrees on the whole with the changes in the depth of the snow cover, which during the same period increased up to 50 per cent. in the mountain area of south-east Norway, but decreased up to 25 per cent. in the area between the inner parts of Hardangerfjord and the inner Trondhjem district. Thus in the inner Sognefjord the decrease in the depth of snow cover has been 2½ times greater than the decrease of the winter precipitation; this may be connected with the increased winter temperature (+1°), and the resulting decreased precipitation falling in the form of snow.

Recent climatic changes in Denmark have been studied by L. Lysgaard.[2] On the whole the results agree with those from Sweden and Norway. The mean yearly temperature in Copenhagen increased by 1° between the periods

[1] In a newly published study ("On the climate of the lofty mountain region of southern Norway," *Meteorologiske Ann.*, Oslo, 2 (1948) 403–64) F. Spinnangr and O. Eide have shown that at the thirteen stations examined in the high mountains of southern Norway the annual temperature means up to 1946 had increased by 0·1–0·8° above the normals for the period 1901–30.

[2] L. Lysgaard, "Änderungen des Klimas von Dänemark seit 1800," *Meteorolog. Zeits.*, 1937, pp. 109–12.

1836–65 and 1906–35. Since 1798 the rise has been most marked in the months December to March (January +2·3°). April, June, July, September and October show hardly any improvement. Of special interest is the fact that there has been an increase in the mean barometrical pressure difference between Fanö in south Jutland and Skagen in the extreme north. During the last fifty years the average pressure gradient has risen by 39 per cent., the increase being greatest in January with 42 per cent., least in July with 10 per cent. Consequently the velocity of west and north-west winds over Denmark has shown a distinct rise since 1873.

When I was speaking of this climatic improvement in Copenhagen in February last year it was very cold, as it was here in England, and people had no fuel for heating. The day after my lecture the newspaper *Politiken* published a drawing called "Propaganda for Optimism." The husband is shown going to bed in the icy room where his wife is already installed. Both are dressed suitably for the "improved" climate. The husband has a pocket flask of brandy in his hand and is saying: "Things are looking up, my dear. The meteorologists say that the temperature during the last 200 years has risen 2° and the glaciers are disappearing in northern Norway." To which his wife answers hopefully, "Thank goodness for that."

From a more scientific standpoint I can say, first, that it may often happen that a year falls completely outside the main trend of a series. Secondly, the winter of 1946–47 was in fact the mildest ever recorded in Greenland and Spitsbergen. But, thirdly, it is also possible that the cold winters during the last few years, beginning with 1940–41, mark a break in the previous epoch of mild winters.

Proceeding eastwards, we come next to Finland. In a lecture given as early as 1941 (but not published until 1944) J. Keränen [1] began by saying that it is now no longer possible to deny that the climate is improving, although this is contrary to the old meterological school of thought which affirmed the stability of the present climate. Keränen's investigations show that between the periods 1899–1908 and 1929–38 temperatures in Finland improved at all seasons. At Uleåborg the winter temperature increased by 2·7°, the spring by 1·4°, the summer by 1·5°, the autumn by 1·7°, and the annual mean temperature by 1·8°. The corresponding figures for Helsinki are 1·8°, 1·4°, 1·5°, 1·5° and 1·5°. Of special importance, particularly to agriculture and forestry, is the lengthening of the period of vegetation growth. Compared with the normal period 1901–30, this had lengthened by 13–16 days in most parts of Finland in 1934–38, and by no less than 21–24 days or even more on the south-west coast.

A sensitive index of variations in climate, particularly of temperature, in Finland and in the Baltic region as a whole, is the extent of the ice at the coasts. R. Jurva [2] has treated the phenomena in detail, and published certain results in a short but comprehensive article. He points out that at Helsinki,

[1] J. Keränen, "Über die Temperaturschwankungen in Finland und Nordeuropa in den letzten hundert Jahren," *Sitzungsber. Finn. Akad. Wiss.*, 1941, Helsinki, 1944.

[2] R. Jurva, "Über die Schwankungen der grössten Vereisung der Ostsee nebst ihren Meerbusen sowie der Sonnenflecken" (Finnish with a German summary), *Terra*, Helsinki, 54 (1942) 41–65.

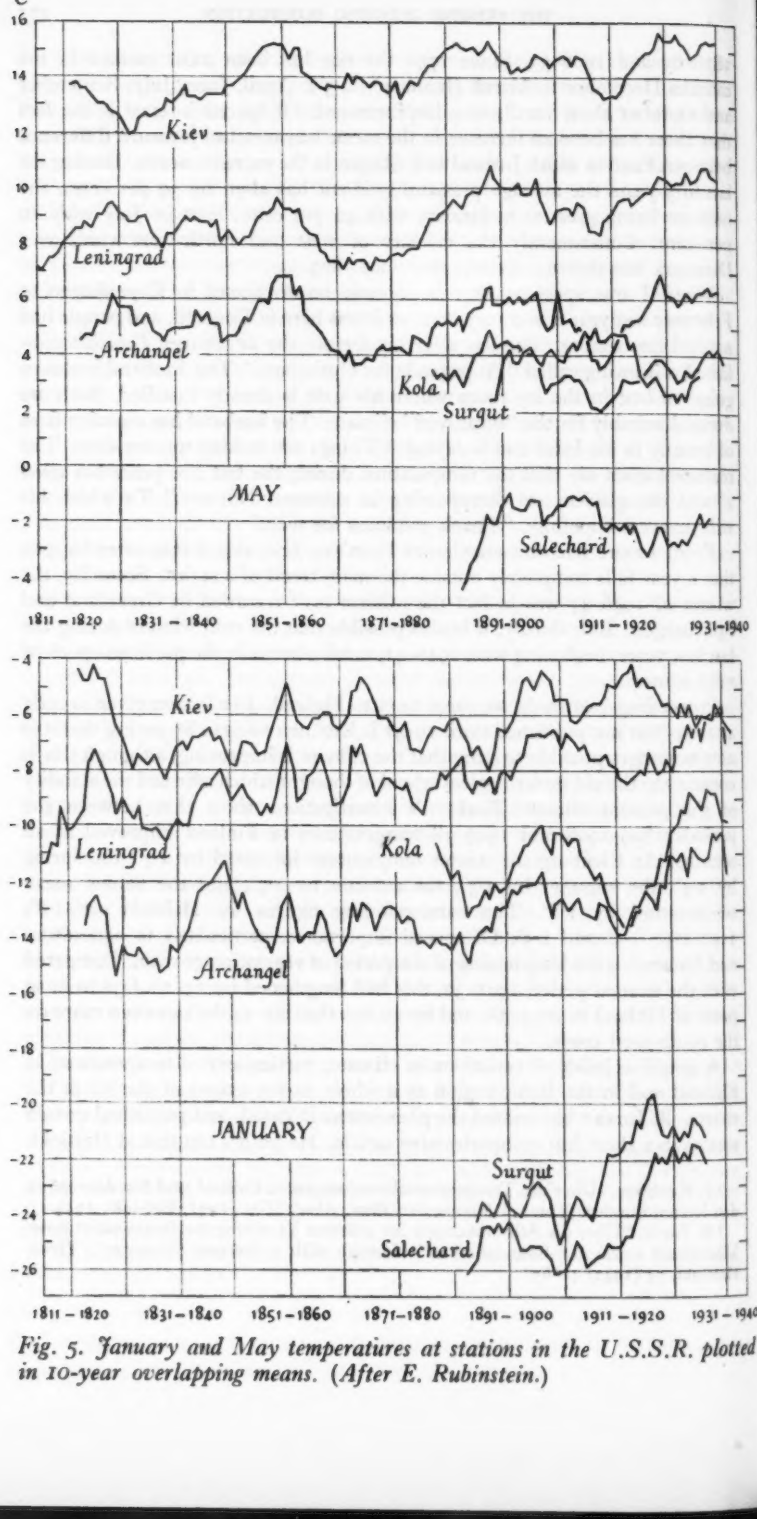


Fig. 5. January and May temperatures at stations in the U.S.S.R. plotted in 10-year overlapping means. (After E. Rubinstein.)

while the winter temperatures of 1921–22 and 1928–29 showed a difference of 5 per cent., the difference in the extent of the ice was 50 per cent. The secular change reflected in the extent of the ice during the period 1830–1940, calculated in 33-year overlapping means, shows a continuous decrease from 250,000 sq. km. at the beginning of the period to 180,000 at the end. The most remarkable period was that of the 1930's when the ice was exceptionally restricted. Lecturing in Stockholm in May 1948, Jurva remarked that so far the 1940's had been equally distinguished by winters with exceptionally heavy ice.

As regards the U.S.S.R., L. Rubinstein [1] has published a climatological study of her country. From Fig. 5 it appears that an increase in winter temperatures began about the latter part of the nineteenth century, and that it was especially marked at such far northern stations as Kola, Archangel and Leningrad, while no increase was noticeable, for example, at Kiev.[2]

Fig. 6 illustrates the divergence of the December temperature and the mean annual temperature in 1929–38 from the average for the period 1881–1938 for the whole Arctic. The greatest positive anomalies are to be found in January and February. During the latter month we find the values $+5°$ and $+6°$ recorded from West Greenland and Spitsbergen. The whole Arctic lies inside the $+1°$ line. On these maps the temperature improvement does not extend over most of Europe, the easternmost Arctic, Asia, and the northern Pacific Ocean. One must however remember that the records from large parts of these areas are very scanty and not as good as they might be.

In attempting to define the meteorological cause of the very remarkable climatic change in the Arctic and Subarctic regions, we speak of increased atmospheric circulation or increased transfer of heat from low to high latitudes. In 1924 A. Defant [3] published his important work on changes in the atmospheric circulation over the North Atlantic, three years after publishing his principal work [4] on the atmospheric circulation in temperate latitudes. These were followed by A. Wagner's [5] analysis of changes in the general circulation based upon the same material and covering the periods 1886–95 and 1911–20, which was included in the then newly published *World Weather Records*. The fact that the temperature is gradually increasing in the north has thus been connected with the circumstance that—assuming the

[1] L. Rubinstein, "K probleme izminenija klimata" (Data on the problem of the variation of climate), *Sci. Res. Dept. Ser., Hydr.-Met. Service, U.S.S.R.*, Leningrad and Moscow, 1946, pp. 1–84.

[2] With the support of information from Russian newspapers, Dr. Bergins states in *Neue Zürcher Zeitung* (14 March 1948) that the rapid fall of the surface of the Caspian Sea must be due to a climatic change with increasing dryness in the Kama and central Volga drainage areas. It is reported further that the annual evaporation from the Caspian Sea is calculated at 15,000 mill. cu. m., while the Volga's discharge is only 3,000 mill. cu. m.

[3] A. Defant, "Die Schwankungen der atmosphärischen Zirkulation über dem Nordatlantischen Ozean im 25-jährigen Zeitraum 1881–1905," *Geogr. Ann.*, 6 (1924) 13–41.

[4] *Idem*, "Die Zirkulation der Atmosphäre in den gemässigten Breiten der Erde," *Geogr. Ann.*, 3 (1921) 209–65; see also R. Hillebrand, "Untersuchungen über den atmospharischen Grossaustausch und seine Bedeutung als Klimafaktor." *Veröff. d. Geophys. Inst. Univ. Leipzig, Zweite Serie*, Leipzig, 11 (1939) 307–92.

[5] A. Wagner, "Untersuchungen der Schwankungen der Allgemeinen Zirkulation," *Geogr. Ann.*, 11 (1929) 32–88.

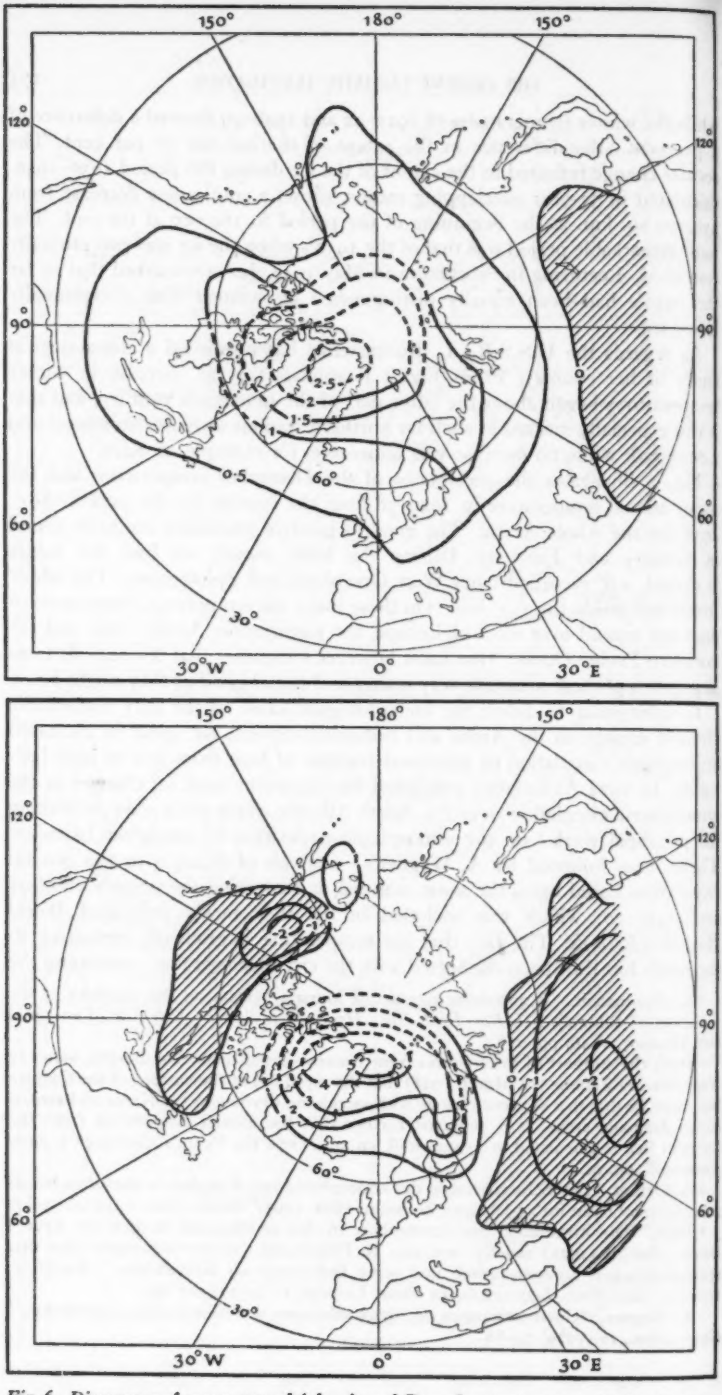


Fig. 6. Divergence of mean annual (above) and December temperatures in the Arctic in 1929–38 from the average for the period 1881–1938. (After E. Rubinstein.)

mean air temperature of the earth to remain practically constant during a change in the atmospheric circulation—the extensive area of the low latitudes would show only slight changes while the relatively small area of the higher latitudes would show much larger ones. Sir G. T. Walker,[1] in a paper published in 1932, discussed the inter-relations between winter temperatures and other elements at a number of stations round the Atlantic. According to him, warm winters in Scandinavia and cold winters in Greenland and Labrador appear to be associated.

The theory that increased atmospheric circulation is the essential cause of the climatic improvement has been supported by Backa Eriksson's [2] analysis of barometric pressures, winds and drift ice in the northernmost Atlantic. It seems to him that the immediate cause of the general improvement of the climate in these regions has been a general intensification of the atmospheric pressure gradient, providing increased supplies of warm air. His investigations have also demonstrated that while the mean winter atmospheric pressure has been considerably reduced, the summer pressure has generally remained the same or—in certain districts of Norway—even increased slightly. Hence a southerly extra wind component has been superimposed on the mean wind of 1901–30, rendering possible an increased transfer of heat. The location of the maximum increase of temperature in the far north is explained by the fact that the low pressure area in the North Atlantic has moved abnormally far to the north, thereby changing the direction of the atmospheric pressure gradient so as to increase the flow of warm air to these arctic regions. The climatic change has thus obviously been associated with changes in the direction and force of the winds. This is one of the chief reasons for the good pack-ice conditions observed in recent decades in this part of the Atlantic as well as in the arctic waters of the Soviet Union.

G. W. Brier has come to the conclusion that his analysis of the pressure data from the Daily Historical Map series [3] "indicates a considerable decrease in the total mass of air over the Northern Hemisphere between 1899 and 1939. This trend toward lower surface pressure was more pronounced in the higher latitudes while some regions near the equator showed slight trends in the opposite direction." This downward trend in pressure in the northern hemisphere and the general warming up of the hemisphere, as reported by J. B. Kincer [4] and others, " is directly associated with an increase in the speed of the prevailing westerlies."

In an article [5] published in 1947 Sir Gilbert Walker attempted to provide a satisfactory series of annual values for the arctic pack ice that drifts across the

[1] G. T. Walker, " World Weather, 6," *Mem. R. Met. Soc.*, vol. 4, 1932.

[2] Backa E. Eriksson, "Till kännedomen om den nutida klimatändringen inom områdena kring nordligaste Atlanten" (with an English summary), *Geogr. Ann.*, 25 (1943) 170–201.

[3] G. W. Brier, "40-year trends in northern hemisphere surface pressure," *Bull. Amer. Met. Soc.*, 28 (1947) 237–47. The maps are compiled jointly by the U.S. Weather Bureau, Washington, and the U.S. Army Air Forces. See also *Nature*, 161 (1948) 730.

[4] J. B. Kincer, "Our changing climate," *Trans. Amer. Geophys. Union*, vol. 27, no. 3, 1946.

[5] G. T. Walker, "Arctic conditions and world weather," *Q. J. R. Met. Soc.*, 73 (1947) 226–56.

Greenland Sea and to correlate it with conditions of pressure and temperature in Europe. To quote from his own abstract of the article: "relationships of the ice with previous conditions are closer than those with subsequent ones, and led to a forecast for which R=0·66, a value too small for ordinary use. For the ice off the Newfoundland Banks the data are more complete but more baffling. The coefficients of −0·76 and −0·70 of this ice with previous pressure in Iceland and Greenland, based on over twenty years, have become small and positive; some relationships with European weather are found and an attempt to derive an alternative method of forecasting meets with but limited success."

Rubinstein illustrates the relation between air pressure and temperature anomalies by the following examples. In January 1917 and in February 1929 the positive anomalies on the west coast of Greenland were as high as 10–15°. In these months the Icelandic low pressure area was displaced towards the west. In January 1918 and January 1925 the temperature on the Greenland coast was, by contrast, 6–7° below the normal. In these months the Icelandic low pressure and the Azores high pressure centres were displaced eastwards. In the former year (1918) the Icelandic low pressure area was situated as far east as the Kola peninsula while the Azores high pressure area was centred over the Mediterranean.[1] A wide field of further meteorological research is in prospect here. It is probable that the barometrical pressure gradient between the Icelandic minimum and the Azores maximum plays an important rôle.

Rubinstein expresses herself very vaguely as regards the general causes of the climatic fluctuation. She says only: "a certain difference in temperature between the Equator and the North Pole corresponds to a certain intensity in the atmospheric circulation and to a certain value of the *Austauschkoefficient* in Defant's formula. If the circulation increases, this coefficient also increases and the transfer of air to the arctic regions will be intensified. The result is that, on the other hand, the temperature difference between low and high latitudes diminishes. There will be pulsations in the intensity of the general atmospheric circulation, which is self-regulating. Sometimes, however, this chain of events is broken by special impulses, and changes in the system of circulation are introduced which persist for a longer or shorter time."

Examining the question of the causes of the intensified atmospheric circulation, especially in the North Atlantic area, B. Helland-Hansen and F. Nansen [2] have come to the conclusion that the temperature variations in the waters of the North Atlantic Ocean and in the atmosphere above must be dependent on variations in solar radiation. They write that "the effect of such variations are first observed in the distribution of pressure, when the observations are made at the earth's surface." "Changes in the solar radiation cause temperature changes in the atmosphere, chiefly in the troposphere and at cloud-formation." "An increased supply of energy will cause increased

[1] See also J. Sandström, *Ymer*, Stockholm, 59 (1939) 58, cited by G. Manley *Q. J. R. Met. Soc.*, 70 (1944) 212–3.

[2] B. Helland-Hansen and F. Nansen, "Temperature variations in the North Atlantic Ocean and in the atmosphere," *Videnskapsselskapets Skrifter*, I. Mat.-Naturv, Klasse 1916:9; also published in *Smithsonian Misc. Coll.*, vol. 70, no. 4, Washington, 1920. *Idem*, "Sunspot changes and weather changes," *Smithsonian Misc. Coll.*, vol. 104, no. 19, 1946.

movement in the atmosphere, and this will again affect the temperature at the earth's surface, differently in the different regions." At about the same time H. Helm Clayton [1] showed that the rising trend of temperature records is world-wide and that the most probable cause is increasing solar radiation. In a series of articles A. Ångström [2] has treated the relation between variations in the heat energy received by the earth from the sun, the atmospheric circulation and the temperature distribution between the equator and the pole. C. E. P. Brooks [3] has pointed out that the earth's climatic pattern is rather critically balanced, and that a relatively small change in the heat received at the earth's surface will directly and indirectly have a marked effect on the circulation of the atmosphere and the distribution of temperatures. L. Lysgaard adds, in a private letter relating to his article in *Nature*, that judging from his own observation material the sun must be responsible for the climatic change.

Concluding his critical survey of the observations of previous workers as to the secular, climatic and geological variations of world weather patterns, H. C. Willett [4] says that the most significant fact revealed by that survey "is the basic similarity of all these pattern changes, and the essential resemblance of the pattern extremes to the high and low index patterns of the anomalous fluctuations of the general circulation. If it is accepted that some common factor or set of factors of climatic control operates in all of these irregular cyclical changes of the general circulation, then irregular solar activity, very probably of the variety indicated by sunspots, remains by elimination as the only obviously possible explanation."

We must remember however that our present knowledge of the extent of the climatic fluctuation is hardly comprehensive enough to allow us to characterize it as world-wide. We cannot as yet say anything with certainty about the Antarctic, which is of such great importance in this context. Therefore it is as yet only a hypothesis to hold the sun responsible for the fluctuation. The present rapidly growing understanding of the importance of the stratosphere to the earth's climate must also be taken into consideration in discussing the whole problem. However, as more areas are investigated as a result of the increasing interest in the present climatic fluctuation, the more extensive the phenomenon seems to be.

In the U.S.A., J. B. Kincer [5] observed the present climatic change as early as 1933, followed by H. M. Raup,[6] L. F. Page [7] and others. Here we can recognize many features resembling those in Europe. For example, tempera-

[1] H. Helm Clayton, "Effect of short period variations of solar radiation on the earth's atmosphere," *Smithsonian Misc. Coll.*, vol. 68, no. 3, 1917.

[2] *Gerlands Beitr. Geophysik*, vol. 15, 1926; *Geogr. Ann.*, 12 (1930) 130–59; *ibid.*, 21 (1939) 119–31.

[3] Brooks, *op. cit.*

[4] Willett, *op. cit.*, p. 109; and by the same author, "Our changing climate," *Trans. Amer. Geophys. Union*, vol. 27, no. 3, 1946.

[5] J. B. Kincer, "Is our climate changing? A study of long-time temperature trends," *Mon. Weather Rev.*, Washington, 61 (1933) 251–60.

[6] H. M. Raup, "Recent changes of climate and vegetation in southern New England and adjacent New York," *J. Arnold Arboretum*, Jamaica Plain Mass., 18 (1937).

[7] L. F. Page, "Temperature and rainfall changes in the United States during the past forty years," *Mon. Weather Rev.*, 65 (1937) 46–55.

tures in Philadelphia and New Haven, Connecticut, have increased since the middle of the nineteenth century; evaporation in Colorado has increased; the Great Salt Lake has lost nearly 50 per cent. of its volume, and the salt content of its water nearly doubled between 1877 and 1940 [1]; precipitation in Baltimore and Boston and the percentage growth of tree-rings have decreased. For other examples I would refer you to Tannehill's book, 'Drought.' [2]

In *Nature* for March 1948 L. Lysgaard [3] gives a short account of his work on temperature and precipitation for the whole earth, in which he compares conditions in the period 1881–1910 with those in the period 1911–40. He says: "Over great parts of the earth, especially in temperate and arctic zones, both winter and summer temperatures seem to have been subjected to an appreciable increase, while over other parts, especially in the tropical and sub-tropical zones, a decrease of temperature has taken place.[4] Also an increase in rainfall is recorded over great parts of the temperate and arctic zones and over the monsoon regions of south-east Asia, while a decrease is recorded over other tropical and sub-tropical regions, such as Africa, Australia, Brazil and the United States."

Although, as I have said, much work still remains to be done before we can make a true statement about the total extent of the present climatic fluctuation and its causes, it is a fact that this is *the first fluctuation in the endless series of past and future climatic variations in the history of the earth which we can measure, investigate and possibly also explain.* To my mind the importance of this fact cannot be exaggerated. For this reason it is of the utmost importance to discover in what other ways the present climatic fluctuation has manifested

[1] For the Great Salt Lake curve special observations have been made at my request by the Department of Geography in Berkeley, California. J. Leighly writes: "One cannot judge much concerning changes in climate from the fluctuation in lake levels alone. There have been, since the middle of the last century, several cultural disturbances. First heavy grazing by sheep, which disturbed the vegetation already in the 'sixties. Later, the use of water from tributary streams for irrigation has affected the inflow into the lakes." Before the establishment of the gauge at Salt Lake City in 1868 there was a rise in the water surface of some 10 feet for the period 1845–67. The precipitation in California has however "decreased, not regularly, of course, but noticeably when the curve of precipitation is smoothed, since the beginning of observations in 1849." Nevada City had a minimum for the period 1915–34, 25 per cent. lower than for the period 1863–82. It is also important that "combined with the gradual decrease in total seasonal precipitations it appears that the regime of precipitation common to southern California has been moving, or rather expanding, northward during the period of record of now nearly 100 years." Professor Leighly considers "that this change is in accordance with what has been found concerning temperature changes in higher latitudes."

[2] I. B. Tannehill, 'Drought,' Princeton, 1947.

[3] L. Lysgaard, "Recent climatic fluctuations," *Nature* 161 (1948) 442.

[4] This agrees with A. Ångström (*Ymer*, 59 (1939) 62–76). In order to illustrate the geographical distribution of the climatic fluctuation, he has plotted the differences between the annual means for the periods 1901–30 and 1856–1900. From this map Ångström has drawn the following conclusion: While there has been a pronounced rise of temperature over all north and east Europe, which on the whole—as far as can be judged—increases from south-west towards north-east, the annual mean has decreased in the south-west corner of Europe and in those parts of North Africa from which sufficiently long series are available. That decrease has been slight, but in view of the continuity of the geographical distribution it is nevertheless large enough to be a definitely proved fact.

itself and has thus provided confirmatory evidence. This is the more desirable as nearly all temperature records are to some extent artificial, since they are taken within screens at fixed heights above the ground. We will look first at glaciers, as they are very sensitive registers of change in temperature and precipitation.

Glaciological evidence

After studying the literature about glacier variations,[1] the Icelander Sigurdur Thorarinsson has come to the following conclusion: "the marginal variations of the glaciers in recent centuries have in all probability been more or less concurrent all over the world." The majority of the glaciers in practically every glacial district of the world—outside the Antarctic of which we know almost nothing—are now receding. In his report of the Committee on Glaciers,[2] F. E. Matthes says: "likewise glaciers in nearly all parts of the world receded irregularly during the last 60 years, but especially rapidly during the 1930–40 decade."

Briefly summarizing the results of work on glacier budgets and their variations in the North Atlantic area, we can say [3]:

(1) All the glaciers examined are shrinking. The decreasing thickness of the glaciers has been greater than the recession of their margins. The rate of decline has increased during the last decades. This reduction of glacier volume stands out as the latest stage in a shrinkage which began about 200 years ago when the local glaciers reached their maximum extent in historical times, perhaps even in post-glacial times.[4] Some glaciers have declined to such an extent that their existence will be in danger if present conditions continue in the coming decades. Some small glaciers have already disappeared.

(2) All the glaciers in recession have a strongly negative budget; that is, lose more material by ablation than they receive by accumulation.

(3) Temperature has at present a greater effect on glacier regime than has precipitation, especially in lengthening the ablation season.[5]

[1] S. Thorarinsson, "Present glacier shrinkage, and eustatic changes of sea-level," *Geogr. Ann.*, 22 (1940) 131–59. See also L. C. W. Bonacina and E. L. Hawkes, "Climatic change and the retreat of glaciers" (with discussion), *Q. J. R. Met. Soc.*, 73 (1947) 85–95.

[2] *Trans. Amer. Geophys. Union*, vol. 27, no. 2, 1946.

[3] For glaciers in districts around the northernmost part of the Atlantic, see H. W. Ahlmann, "Glaciological research on the North Atlantic coasts," R.G.S. Research Series, No. 1, London, 1948.

[4] The discovery of a wooden-shafted arrow head of a type from A.D. 400–500, recently exposed by the melting away of a snow-field on the Opdal mountains in Norway, has led K. Fægri in Bergen to the following, probably correct, conclusion: "the yearly snow surplus in the 'thirties was smaller than at any time since the migration period, but it must then have been correspondingly small. There is some reason to believe that the preceding archaeological period, the earlier Roman Iron Age, was characterized by a genial climate, and that not only the snow patches but also the glaciers were as small as—or most probably much smaller than—they are to-day. We may even question if any living glaciers then existed in Western Norway" ("Forandringer ved norske breer 1936–37," *Bergens Mus. Årsbok* 1938, *Naturv. raekke*, no. 4 (1939); and "On the variations of western Norwegian glaciers during the last 200 years," *Rep. Internat. Union Geophys.*, Oslo, August 1948, p. 4.)

[5] In spite of the varied distribution of the increased precipitation in Norway, already remarked, the glaciers are shrinking not only in areas where the winter precipitation

(4) At low altitudes heat received through the atmosphere (convection) is of greater importance than radiation from sun and sky; this is especially so in high latitudes and in maritime climates.

The Icelandic glaciers have had two maximum extensions, the first during the middle of the eighteenth century, the second one hundred years later. Since the end of the nineteenth century the Vatnajökull outlet glaciers have been retreating at gradually increasing rates even during the last few years. The same conditions are found in Norway. The outlets of the vast Jostedal glacier cap in south Norway reached their maximum extent since the Ice Age about the middle of the eighteenth century, after the so-called "green years," 1770–72, when corn did not ripen but stood green in the fields the whole summer. Since then they have been in recession, interrupted however by smaller advances lasting some decades. Since 1910 their total recession has been 490 m., which means that some of these outlet glaciers have

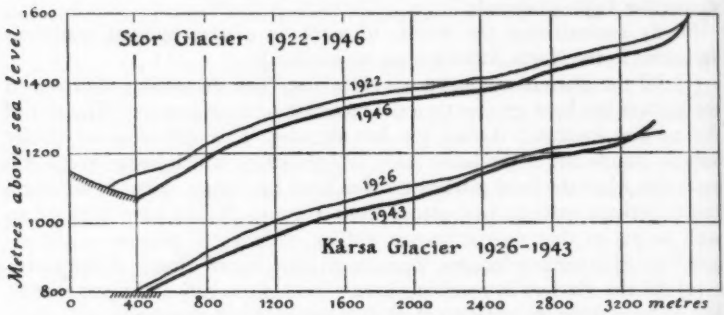
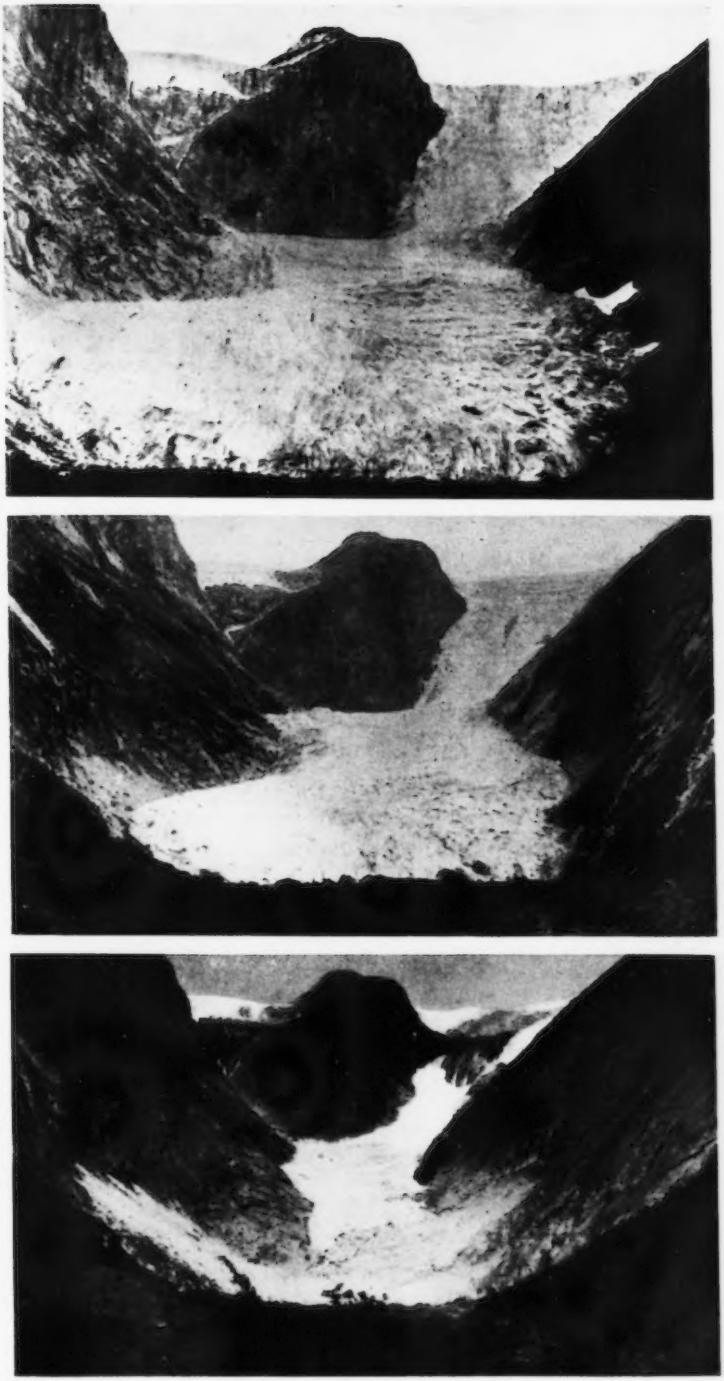


Fig 7. Longitudinal profiles of Stor and Kårsa glaciers. (*After V. Schytt.*)

completely disappeared or are reduced to but a fraction of their former size. The plate facing shows the Åbrekke glacier, an outlet to the Jostedal glacier cap. The mass of ice on the valley floor in 1869 was greatly reduced by 1933 and had practically disappeared by 1946. No ice from the glacier cap on the high plateau in the background flows over the steep slope; the remaining ice on the valley bottom is dead and will very soon have melted away; perhaps it has already vanished. During the last few years the firn limit on most Norwegian glaciers has risen above their upper limits, so that the glaciers are living only on their own mass without receiving any annual supply of fresh snow.

and the depth of the snow cover have decreased but also in those where they have increased. The general increase of precipitation during the winter which characterizes the present climatic fluctuation is more than compensated by the increase in temperature, the resulting prolonged ablation period and the decreased share of precipitation in the form of solid matter. At Fanaråken (2065 m. above sea-level), representing the Jotunheimen glacier district, the mean annual temperature has risen by 0·4° in the period 1933–46 above the normal for 1901–30. The mean annual precipitation has been placed at 1720 mm. (1933–46); my figure for the adjacent Styggedal glacier was 1100 mm. at 1650 m. above sea-level.



Åbrekke glacier, Jotunheim, showing recession in 1869, 1933 and 1946

The Swedish glaciers show much the same development as those in Norway. The Stor glacier (3·3 sq. km.) in the Kebnekajse massif in Lapland has for three years been the object of systematic study as the Scandinavian base in an international network of coordinated glaciological research.[1] The glacier decreased in volume by about 70 mill. cu. m. between 1922 and 1946, an average of 0·8 per year per sq. km. (Fig. 7). The regime of the glacier during the last two budget years is shown in the table below. The net loss in the first year was 0·6 mill. cu. m. of water per sq. km., in the second 1·9. I may add that the Kebnekajse massif is capped by a small ridge-shaped glacier, forming the highest point in Sweden. This glacier has also diminished in height by about 9 m. since 1902.

Regime of the Stor glacier (in million cu. m. of water)

Year	*Accumulation*	*Ablation*	*Regime*	*Net loss*
1922–45				about 70 (=0·8 per sq. km.)
1945–46	3·5	5·5	9·0 (=2·7 per sq. km.)	2·0 (=0·6 ,, ,,)
1946–47	3·2	9·6	12·8 (=3·8 ,, ,,)	6·4 (=1·9 ,, ,,)

Just the same circumstances as those in Scandinavia are to be found in all districts round the northern Atlantic; in Spitsbergen and Iceland, and in Greenland right up to its northernmost part, Peary Land, as was found by the Danish expedition in 1947. The last decades have reduced the ice in some parts of Greenland to such an extent that the whole landscape has changed its character.[2]

In considering these variations and their inter-relations, the following fact is of interest. The extent and volume of the Styggedal glacier in central south Norway and of the Fröya glacier in north-east Greenland at the time of their maximum advance can be calculated by carefully measuring the areas outside their terminal and lateral moraines and on the adjacent valley walls which have not yet been covered by lichens and other plants since the ice began to recede. The area and volume obtained are of the same order of magnitude for both glaciers. An examination of the collection of fine air-photographs taken in 1936 and 1938 for the new survey of Spitsbergen, now at the Norwegian Polar Institute, has shown that in the Ice fjord district some glaciers had retreated as much as 4·5 km. since 1908, when their margins were mapped by G. de Geer, while others had remained in about the same position Some glaciers, for example Von Post glacier, have oscillated widely during the last decades but have been in rapid recession since 1936 as have most glaciers not only on the west coast but also on the east and north coasts. In the Alps the shrinkage and retreat of the glaciers during the summer of 1947 was catastrophic in character. Some glaciers, for example one of the well-known ones in front of the Berliner Hütte, have completely disappeared.[3]

Yet all the facts about glacier shrinkage in Europe seem to be put in the

[1] V. Schytt, "Glaciologiska arbeten i Kebnekajse," *Ymer*, 67 (1947) 18–42.

[2] In the October 1948 issue of the *Journal of Glaciology* (vol. 1, pp. 167–81) J. N. Jennings gives a more detailed account of the glacier retreat in Jan Mayen.

[3] R. von Klebelsberg, "Die Gletscher der österreichischen Alpen 1944–47," *Mitt. österreichischen Alpenvereins*, Innsbruck, 1948.

shade by what has taken place in Alaska, where the vast Muir glacier in Glacier Bay retreated 22 km. between 1902 and 1946, an average of 400 m. per year.[1] This summer the American field of glaciological research in the international network will be based on St. Elias mountain in Alaska and on Baffin Land in the Canadian arctic archipelago.

Turning to climatic fluctuations in low latitudes, I will begin by reminding you that a glacial recession in South America began about 1860.[2] Then let me give you some facts from East Africa, which was visited by E. Nilsson of Stockholm Univèrsity in January 1947 in connection with the archaeological congress in Nairobi.[3] Dr. Nilsson is well known for his study of some parts of this region in 1927 and 1932 from the point of view of Quaternary climatology.[4]

The present-day changes in East Africa, like earlier ones, are being registered by fluctuations of the glaciers on the highest mountains and by changes in the levels of the lakes without outlets in the Rift valley. The glaciers on the three high East African volcanoes, Kilimanjaro, Mount Kenya and Ruwenzori, have been diminishing since they were first observed in the 1880's. Since 1920 this decline has proceeded more rapidly than before. In January 1928 three of the larger glaciers (Credner, Drygalski and Penck) on the north-west slope of Kibo, the highest summit of Kilimanjaro, were outlets from a common icefield covering the north and north-west sides of the crater of Kibo.[5] In January 1947 they had thinned considerably and the Penck glacier had divided into two parts. Since 1942 all the glaciers on Kilimanjaro have been the object of regular observations by J. J. Richard, who has promised to send his results to Dr. Nilsson. From Mount Kenya and Ruwenzori there is similar information about the rapid decline of the glaciers during the last fifteen years.

During the last thirty years the levels of the East African lakes have shown a very marked lowering. Lake Nakuru in the rainy season holds only a shallow layer of water which rapidly dries up, except for some pools in its eastern part. In February 1947 the bottom was white with soda and other

[1] W. O. Field, "Glacier recession in Muir Inlet, Glacier Bay, Alaska," *Geogr. Rev.*, 37 (1947) 369–400.

[2] According to E. Feruglio ("Variaciones del frente del Glaciar Moreno," *An. Soc. Argentina Estud. Geogr.*, Buenos Aires, 6 (1938) 185–92),the Moreno glacier terminating in Lago Argentina advanced between 1899 and 1917, receded from then until 1926, after which a new advance began, culminating in 1932–35. Since then the glacier has retreated continuously. J. A. Broggi ("La desglaciación actual de los Andes del Perú," *Bol. Soc. Geol. Perú*, 14–15 (1943) 59–90) has collected and analysed available information on the retreat of glaciers and the névé line in the Peruvian Andes, and has come to the conclusion that there has been a general glacial decline in Peru since 1862, with a period of slight readvance between 1909 and 1932, followed by accelerated retreat in the last decade.

[3] E. Nilsson, "Den nutida klimatförändringen i Ostafrika," *Ymer*, 67 (1947) 161–72.

[4] *Idem*, "Quaternary glaciations and pluvial lakes in British East Africa," *Geogr. Ann.*, 13 (1931) 241–348; "Traces of ancient changes of climate in East Africa," *ibid.*, 17 (1935) 1–21; "Ancient changes of climate in British East Africa and Abyssinia," *ibid.*, 22 (1940) 1–79.

[5] P. C. Spink, "Further notes on the Kibo inner crater and glaciers of Kilimanjaro and Mount Kenya," *Geogr. J.* 106 (1945) 210–6.

salts, and the warm afternoon winds would blow the salt and dust into white clouds over the lake depression. Lake Elementeita, south-east of Lake Nakuru, has nearly dried up; its depth is now only about 2 feet. The level of Lake Naivasha in the neighbourhood of Nairobi has been measured monthly ever since 1908. According to H. L. Sikes,[1] the lake had a low water level up to 1882, when a rise began. Since 1917 the water level has been rapidly falling again, concurrently with a serious decrease in precipitation. Again, the level of Lake Victoria has fallen during the last ten years by about 7 feet.

Two letters from Kenya dated March and April 1948 give different aspects of the same phenomenon: one speaks of the necessity of drilling holes 400 feet deep to reach water; the other states that last year was the wettest in twenty years, but that the precipitation was badly distributed. Lake Nakuru has not altogether dried up this year though somewhat shrunken.

The parching of vast areas of Africa has been taking place for a long time. According to E. P. Stebbing the Sahara has encroached southwards at a mean rate during recent centuries of 1 km. per year. During the last few years a remarkable decrease in rainfall has also occurred in Morocco. At

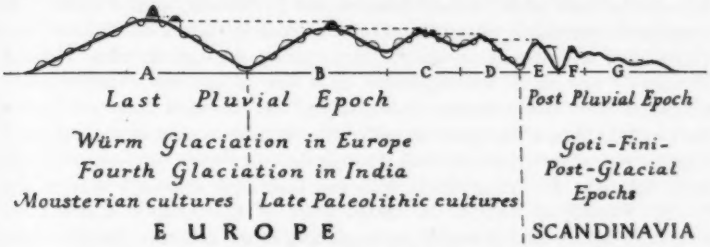


Fig. 8. Variations of Nakuru Lake level. (After E. Nilsson.)

one time we were apt to look upon this water decrease as a result of native exploitation of the cattle fields and the white man's plantation farming, and the general increased need for water. But the facts given above, and particularly those relating to East Africa, can hardly be explained by anything else than a change in climate. It appears that the climatological regime of East Africa is no longer as stable as it was previously; the atmospheric circulation is somewhat disturbed.

The present climatic fluctuation in East Africa, as elsewhere, is part of the long series of Pleistocene and post-Pleistocene climatic changes. Dr. Nilsson has illustrated the sequence by the diagram reproduced as Fig. 8, which is not drawn to any particular time-scale. During the last glaciation, the Würm in Europe, the surface of Nakuru Lake rose and fell four times with many smaller fluctuations. After that, when the inland ice retreated from the Scandinavian peninsula, and up to our own time, the climate continued to fluctuate, as I have already pointed out, between colder and warmer, more humid and drier epochs. The present fluctuation is not shown in the curve; we do not know as yet if it will be merely a ripple on the rise or fall

[1] H. L. Sikes, "Notes on the hydrology of Lake Navasha," Reps. Nairobi Public Works Dept., Nairobi, 1945.

of one of the big waves of climatic change, which will surely characterize the future as they have done the past.

East Africa, including Abyssinia, is in fact a region of the greatest interest and importance to the study of climatic developments during the last hundred thousand years. It is the only part of Africa where natural and archaeological conditions allow fruitful investigations into these important problems. Of special value would be thorough meteorological research with radio sonde and systematic observations of the glaciers on Kilimanjaro with special regard to sun radiation.

After this excursion to Africa we will return to the northern regions so that I may give you a short account of some consequences of the present climatic fluctuation in other fields than glaciology.

Oceanographical evidence

The hypothesis of an increasing atmospheric circulation over the northern Atlantic leads one to expect the water of the north-going sea currents to be salter and warmer than previously. This is in fact the case. I shall be referring here to the work of B. Helland-Hansen and F. Nansen, quoted above. The continued systematic observations of the coastal waters of Norway have also shown an increase in temperature during the last decades. Helland-Hansen's [1] systematic investigations on a line of sections running north-westward from the entrance to Sognefjord on the west coast of Norway have further shown that quite considerable variations occur in the volume of Atlantic water flowing northwards through the Norwegian Sea—the northernmost Atlantic.[2] Investigations in May and June 1935 and 1936 indicate that in this Sognefjord section the temperature of the Atlantic Current was invariably higher than it was at the beginning of the century. Another series of hydrographic sections along the Kola meridian (33½° E.), which were measured every year by Russian scientists, showed that the temperature to a depth of 200 m. was 1·06–3·48° higher at the end of May 1921 than at the same season in 1900 and 1901; the mean difference was 1·9°. There have been considerable fluctuations since but on the whole the water has become still warmer.

As regards Spitsbergen waters, H. U. Sverdrup's [3] work with the Nautilus expedition in 1931 off north-west Spitsbergen showed that the mean values of temperature and salinity at depths of 200, 300 and 400 m. (observed by Norwegian expeditions at three neighbouring sections in August) had risen since 1912 by 1·5° and 0·2 per mille. This agrees with the conclusions of

[1] B. Helland-Hansen, 'The Sognefjord section. Oceanographical observations in the northernmost part of the North Sea and the southern part of the Norwegian Sea,' (James Johnstone Mem. Vol.), pp. 257–74, Liverpool, 1934.

[2] J. P. Jacobsen ("Zur Diskussion der Arktis zugeführten Wärmemenge; Die Erwärmung der Arktis," *Veröff. Deutschen Wiss. Inst. Kopenhagen, Arktis*, Berlin, 1942) has come to the conclusion that conditions in the Norwegian Sea are more dependent on the displacement of the mass of Atlantic water in relation to the "arctic water" than on variations in the volume of water passing northwards through the channel between the Faroe Islands and Shetlands.

[3] H. U. Sverdup, "Oceanography. Scientific results of the *Nautilus* expedition 1931," Part II, *Pap. Phys. Oceanogr. Met.*, Cambridge, Mass., vol. 2, no. 1, 1933.

H. Mosby,[1] leader of the sea party in the Swedish–Norwegian expedition of 1931, who found that in every hydrographic section measured, both temperature and salinity had risen from the previous recordings of 1910 and 1912. The line of sections between Spitsbergen and Franz Joseph Land showed that "the traces of Atlantic Water in this northernmost part of the Barents Sea were more pronounced in 1931 than in 1923 and 1929, the increase of temperature and salinity being estimated at about 1·00° and 0·04 per mille respectively."

As a result of this warming of the sea water and of the increasing air temperature, the thickness of the ice forming annually in the Polar Sea has—as I said in my lecture here in 1945 [2]—diminished from an average of 365 cm. during the Nansen *Fram* expedition of 1893–96 to 218 cm. during the drift of the Russian ice-breaker *Sedov* in 1937–40. The extent of the pack-ice in arctic waters has also diminished considerably in the last decades. The shipping season for the coalfields in West Spitsbergen has lengthened from three months at the beginning of this century to about seven months during the last few years.

According to information I received when in the U.S.S.R. in June 1945, ice conditions began to improve in the Barents and Kara Seas in 1920, and the improvement has since been gradually extending farther eastwards. In 1940 the whole north coast of Europe and Asia was quite free of ice from the end of August to the end of September. About one hundred vessels were then using this route. There were however several relapses. Ice conditions in the Kara Sea, for instance, were relatively bad in 1933, 1934 and 1936, and in 1942 they were worse all along this route than at any time in recent years. On the basis of charts showing the extent of the drift ice in the Russian sector in each summer month of the year, constructed from air photographs, it has been found that between 1924 and 1944 the drift ice was reduced by no less than 1,000,000 sq. km. I might also mention that two fossil ice islands in the Laptev Sea have melted away completely, leaving only submarine shoals. Of no less practical importance to Russia is the fact that the southern boundary of the perennially frozen ground in Siberia has receded considerably in past decades. Moreover the season when pack ice lies along the north coast of Iceland has become shorter by about two months between the periods 1861–90 and 1911–40.

Biological evidence

Another result of changed conditions is that various kinds of fish have migrated northwards. The most remarkable movements have been those of the common cod (*Gadus Callarias*).[3] In the later years of last century and

[1] H. Mosby, "Svalbard waters," *Geofys. Publ.*, Oslo, vol. 12, no. 4, 1908.

[2] H. W. Ahlmann, "Researches on snow and ice, 1918–40," *Geogr. J.* 107 (1946) 23.

[3] A. S. Jensen, "Concerning a change of climate during recent decades in the arctic and subarctic regions, from Greenland in the west to Eurasia in the east, and contemporary biological and geophysical change," *Kgl. Danske Vidensk. Selsk., Biol. Medd.*, Copenhagen, 14 (1939) 1–76; and with P. M. Hansen, "Investigations on the Greenland cod," *Conseil permanent international pour l'exploration de la mer, Rapports et procès-verbaux*, 72 (1931) 14. See also A. S. Jensen, "Contribution to the Ichthyofauna of Greenland 8–24," *Spolia Zoologica Musei Hauniensis*, Copenhagen, 9 (1948) 144–54. The seas around Greenland have also been remarkably free from ice in recent years, and most West Greenland ports have been able to remain open

beginning of the present, the common cod was found at only a few places in the waters of south-west Greenland and only in small numbers. But since 1917 they have gradually migrated farther north, and in steadily increasing numbers. In 1919 they reached Godthaab at 64° N.; in 1922 Sukkertoppen at 65½°, and five years later Holstinsborg at 67°. In 1930 they reached 70° N. and are now to be found as far north as 73°. Thus the cod has migrated 9° of latitude in twenty-seven years. The cod catch in west Greenland, which was 5 tons in 1913, has increased steadily so that by 1930 it was about 8000 tons, and it reached 13,000 tons in 1946. Now cod has become practically the staple diet of the Greenlanders.

In East Greenland the cod was unknown before 1908 to both the Danes and Eskimo at Angmagssalik at 66° N. But from 1915 onwards they began to appear in small shoals; by 1923 they were fairly common and by about 1930 cod were present almost everywhere in these waters and have since contributed to the people's food supplies. The same general tendency to migrate north can also be proved of a lot of other fish, for example haddock (*Gadus Aeglefinus*), halibut (*Hippoglossus vulgaris*) and herring. It has been stated too that the Greenland cod and herring in recent years have been in contact with those of Iceland. At the same time we have proof that arctic species of fish have kept away from, or shortened their stay in, the waters of south-west Greenland.

The programme drawn up by the North-west Area Committee of the Permanent International Council for the Exploration of the Sea for its meeting in Copenhagen last October also pointed out that "it is clear that some of the largest fisheries in the northern hemisphere—*i.e.* some cod fisheries—during the coming years will be completely dependent on the course of the mild period in northern waters."

The greatest economic benefit derived from the improved climate will, however, be the increased vegetation growth. An extension of barley cultivation has occurred in Iceland. According to Sigurdur Thorarinsson it is also noteworthy that in Iceland the northern species of both birds and insects are gradually disappearing and southern species are taking their place. In Norway, with the exception of the innermost districts of Sognefjord, where the temperature does not show the same increase as in the rest of the country, the limit of cultivation in the mountains has ascended during recent decades. Prospects for agriculture have improved in northern Sweden and Finland, due not only to better seed and improved methods of cultivation but also to the lengthening of the vegetation period. In the forests of northern Scandinavia the economic benefits are of special significance. The trees are spreading rapidly above their former limits,[1] and the annual rings of both pine and spruce show a quicker growth than they have for about two decades.

throughout the winter. In 1942 a Greenland supply vessel unloaded a cargo at Apernavik in latitude 72° 43′ N. during Christmas week in almost complete winter darkness (*Arctic Circular*, Ottawa, 2 (1949) 4).

[1] According to Dr. Sundberg, director of the Abikso Natural Science Station in northernmost Sweden, the vegetation there has changed greatly in the last fifteen or twenty years. Large, formerly bare areas are now being invaded principally by birch and willow (*Salix*); the timberline of the mountain birch is rising higher and higher. Vegetation in general is becoming more luxuriant.

The Swedish Institute of Forest Research has organized a survey of nine hundred samples of untouched forest in all parts of the country. The results so far obtained by measuring series of annual rings indicate a more or less progressive increase in the rate of growth since about the turn of the century. No survey of that kind has yet been made in Norway, but according to information received from the High School of Agriculture at Ås, a multitude of facts point in the same direction. Thus in recent years birch at the timberline in northern Norway has had more favourable regenerating conditions than previously. In Hologaland, between the Trondhjem and Tromsö districts, the fir also seems to regenerate more frequently in the mountains than before. Another significant fact is that while Finnmark, the northernmost part of Norway, had only two seed years of importance in the forty years between 1875 and 1915, good seed years now occur with few interruptions. I. Hustich,[1] one of the first to observe and investigate the influence of the present climatic fluctuation on forest conditions, shows in his latest publications that the growth in diameter of pine near the timberline in the extreme north of Finland, at about 69° 30′–70° N., had a pronounced "low" period at the beginning of this century and a gradual increase during the 1920's; trees at the timberline being very sensitive to even the smaller variations in climate, especially in temperature. The "low" period coincides with relatively bad seed years and a regression of the timberline; the "high" period, with increased July and August temperatures, coincides with relatively good seed years and an advance of the timberline. Climatic variations have also affected the crops of rye, barley, oats and potatoes in northern Finland.

R. Griggs[2] writes of Alaska that nowadays "everything . . . suggested that instead of being held to a stationary line the forest was advancing."

Following up what was said in the introductory pages of this article, about recurrence or heath layers proving climatic changes in the development of bogs, it is also of great interest to notice that in south Sweden, as well as in Germany and Switzerland, the upward growth of high bogs has temporarily ceased and a new recurrence level seems to be forming[3] as a result of the present climatic fluctuation. C.-G. Wenner[4] has found the same phenomenon in Newfoundland–Labrador.

Eustatic evidence

Finally I will touch on a more universal phenomenon. As you may know the storing of water in the ice-sheets during the last glaciation lowered the surface of the oceans. The amount has not been accurately determined, but recent work off the coasts of New Guinea and South Australia seems to confirm the opinion that it was of the order of 90 m. During the recession of the

[1] I. Hustich, "The radial growth of the pine at the forest limit and its dependence on the climate," *Soc. Scient. Fenn. Comm.*, Helsinki, vol. 9, no. 8 (1945) 1–30; *idem*, "On variations in climate, in crop of cereals and in growth of pine in northern Finland 1890–1939," *Fennia*, Helsinki, vol. 70, no. 2 (1947) 1–27. See also *Nature*, 161 (1948); and "The Scotch Pine in northernmost Finland and its dependence on the climatic in the last decades," *Acta Botanica Fennica*, Helsinki, vol. 42, 1948.

[2] R. Griggs, "Timberline as indicators of climatic trends," *Science*, 85 (1937) 251–5.

[3] E. Granlund, *op. cit.*

[4] C.-G. Wenner, *op. cit.*

ice the melt-water drained into the oceans, increasing their volume and raising their surface levels. Sigurdur Thorarinsson [1] has pointed out that the melting of the glaciers during the present climatic fluctuation must also have raised the sea-level. That this is so is proved by B. Gutenberg's [2] analysis of records from gauges or mareographs in different parts of the world; this indicates that the rise during the last decades has been of the order of 1 mm. per year.

In his renewed examination of the data for the period 1890–1944, recorded at gauge stations along the Danish coasts, J. Egedal [3] also discusses the influence of the eustatic variation of sea-level. He comes to the conclusion that the mean eustatic variation in that period has been positive and that it does not essentially exceed 0·5 mm. per year. This relatively small value—0·5 to 1 mm. per year—indicates that the Antarctic and the main part of the Greenland inland ice—together containing more than 90 per cent. of all present land ice—cannot have decreased at the same rate as the local glaciers examined. If the polar inland ice-sheets were to melt as rapidly as the glaciers, the rise in sea-level would become a far-reaching phenomenon of great practical importance.

Finally we must ask ourselves how we can best help to elucidate the whole problem of the present climatic fluctuation. The Antarctic occupies a key position. In addition to thorough investigations in the Antarctic, we must have systematic meteorological observations with radio sonde, if possible in sections right up into the stratosphere and extending from Pole to Pole; from the main antarctic inland ice, over the permanent British stations in Graham Land and on through South and North America. Of no less importance would be a similar section through Africa *via* Kilimanjaro and on through Europe and Spitsbergen.

If we find in the Antarctic similar evidence of the present climatic fluctuation as has been found in other parts of the world, we shall be justified in concluding that the present fluctuation is a world-wide phenomenon and probably the result of variations in solar activity which, slow as they may be to take effect, are actually resulting in an improvement in the climate of our world.

Postscript

A result of the growing interest in most countries in the present climatic fluctuation has been a rapid and continuing increase in the factual information available. This means, of course, that each new contribution to the subject is out of date almost as soon as it is published. Constant revision is therefore necessary. This article has already been enlarged since the lecture on which it is based was given in May last year. The following additional material is mainly derived from the lectures and printed summaries of meetings held during the International Union of Geodetics and Geophysics at Oslo last August.

[1] Thorarinsson, *op. cit.*

[2] B. Gutenberg, "Changes in sea-level, post-glacial uplift and mobility of the earth's interior," *Geol. Soc. Am. Bull.*, vol. 52, 1941. See also H. A. Marmer, "Is the Atlantic coast sinking? The evidence from the tide," *Geogr. Rev.*, 38 (1948) 652–8.

[3] J. Egedal, "On the variations of the normal height of the sea-level round the Danish coasts," *Danske Met. Inst. Aarbog*, 1945, pp. 1–11, Copenhagen, 1946.

Systematic observations of the firn region of the great Aletsch glacier in the Alps by R. Haefeli and P. Kasser show that since 1851, when its farthest limit was reached, the firn shrinkage at one point near the firn line (2993 m.) has amounted to a total of 30 m.; at another point (2789 m.), to 52 m. At this latter point the glacier surface dropped by about 0·73 m. a year in the period 1851–1926 and by about 0·95 m. a year from 1926 to 1947. The annual drop in the firn surface high up on the Jungfraufirn (3350 m.) was 0·41 m. in the period 1926–46, 0·72 m. in 1941–46, and as much as 2·50 m. in the exceptional year 1946–47.[1]

New facts have also been obtained from Alaska, where the very remarkable variations in the glaciers have been thoroughly analysed by W. O. Field, Jr. Most of the glaciers there, he points out, are receding and have withdrawn from terminal moraines formed during the period of maximum advance in the eighteenth and nineteenth centuries. He considers that the present maxima now being reached along the coast may belong to the last phase of this period of glacial expansion which has its counterpart in many other parts of the world. Some glaciers in south-eastern Alaska have now advanced farther than at any time since the eighteenth century and probably earlier. In the neighbourhood of these glaciers, some termini have receded from comparable maximum positions only within the last few decades. Many others, though not now at their maximum positions, remain within a few hundred metres of mature forest. The summer temperature in Alaska in the period 1935–46 was higher than normal and, though the total annual precipitation increased, the amount of annual snowfall decreased. Mr. Field's view is that the advancing glaciers may be reacting to special conditions or to the fact that their sources, at higher altitudes, may be receiving a greater accumulation of snow owing to a regional elevation of the zone of maximum snowfall. In this connection a previously published statement of my own is relevant:[2] "As pointed out in the previous sections, the relative size and altitudes above sea-level of the accumulation and ablation areas are of very great importance to the whole regime. There is a critical point in the ratio of altitude to size of accumulation and ablation areas, at which the effect on the glaciation of increasing conduction of heat and of increasing precipitation changes from positive to negative. In the varying altitudes of mountain regions, therefore, different glaciers react differently even to minor climatological changes; some of them may be advancing, others retreating, and others stagnant."

Short reports not yet published, sent by V. Appenheim and H. Spann to the International Union of Geodetics and Geophysics last August, speak of glacial recession in Colombia and Peru.

Paul-Emile Victor in a report as yet unpublished, dated 29 July 1948, on the French Greenland Expedition, states that the great Eqipsermia glacier (69° N., 50° 15′ W.) has retreated considerably since De Quesvain surveyed it in 1912.

[1] R. Haefeli and P. Kasser, "Beobachtungen im Firn- und Ablationsgebiet des Groses Aletschgletscher," *Schw. Bauzeitung*, Zürich, 35–6 (1948) 3–12.

[2] H. W. Ahlmann, "Glaciological research on the North Atlantic coasts," p. 63, R.G.S. Research Series, No. 1, London, 1948.

Important information regarding temperature changes in Iceland in the periods 1872–1925 and 1926–47 has recently been published by Jon Eythórsson in the newspaper *Landvörn* (Reykjavik, 15 May 1948). The following data are from Reykjavik:

	1872–1925	1926–47	*Difference*
Mean temperature during year	+4·1°	+5·7°	+1·3°
January	−1·0°	+0·3°	+1·3°
February			+1·0°
March			+2·0°
July	+10·6°	+11·8°	+1·2°

Of the other meteorological stations, Stykkisholmur shows that the greatest increase has been during the spring with a lesser increase in the winter and only small increases during the summer and autumn.

At the meeting at Charlottenlund, Denmark, of the International Council for the Exploration of the Sea on 8 October 1948, several reports were rendered —including a summary of this article—of the temperature fluctuations in the northernmost Atlantic.[1] These indicated that the temperature has generally risen in recent decades though it has shown a tendency to fall since the beginning of 1940, for instance, in some parts of the Barents Sea. Not only has this increase of temperature resulted in very bad herring catches off the north coast of Iceland in recent years, probably because—according to Arni Fridriksson—the surface water has been too warm; but the increased Atlantic influence has also to some extent changed the character of the fish fauna. The bird faunas of Iceland, the Faroe Islands and Denmark, as well as of Finland and Sweden have acquired new species from the south, while the native species are now breeding farther north than formerly. The Council adopted the following resolution: "Having considered a number of lectures on climatic fluctuations, the International Council for the Exploration of the Sea recommends that these important and far-reaching problems ought to be more closely investigated, and that these investigations might be adequately supported by the Governments in the different countries." A bibliography of the relevant literature on the problem of climatic and ecological changes in northern waters, comprising 400 items, had been compiled for the meeting.

The following statement by the Danish Prime Minister[2] in a speech on 27 November 1948 is also interesting: "In the last generation changes that have had a decisive influence on all social life have occurred in Greenland. *A new era* has begun. These changes are primarily due to two circumstances. Firstly, the Greenland climate has changed, and with it Greenland's natural and economic prospects. This fact of climatic change has been observed in

[1] *Cf.* papers by J. Smed, "Annual and seasonal variations in the salinity of the North Atlantic surface water," *Rapp. et proc.-verb. des réunions du Cons. perm. internat. pour l'explor. de la mer*, 112 (1943) 79–94; "Monthly anomalies of the surface temperature in the sea round South Greenland during the years 1876–1939," *Cons. perm. internat. pour l'explor. de la mer, Ann. biol.*, 2 (1942–45) 16–22; "Monthly anomalies of the surface temperature in some areas of the north-western North Atlantic in 1876–1939 and 1945–1946," *ibid.*, 3 (1946) 12–24.

[2] *Grönlandske Selsk. Årsskr.*, 1949.

many places spread over all parts of the earth, and is in Greenland made apparent by warmer weather and warmer sea water."

Stockholm, *January* 1949

The above paper was read at the Afternoon Meeting of the Society on 3 *May* 1948.

DISCUSSION

Before the paper the CHAIRMAN (Mr. G. SELIGMAN) said: All foreigners are firmly convinced that the only subject of conversation in this country is the weather. It is nice to think that we are going to be given a new slant on our staple subject of discussion by a speaker from abroad. Professor Ahlmann is too well known to us to need a formal introduction. He is a personal friend of many of us. He has often been welcomed before in this hall and his writings in many languages are well known to most of us. Moreover "good wine needs no bush" and so I will at once ask Professor Ahlmann to pour us out a little.

Professor Ahlmann then read his paper.

Mr. GORDON MANLEY said that he would like to express his great pleasure in hearing Professor Ahlmann again. He doubted whether anyone among those now active had provided more stimulus for geographers and in so many ways. He wished also to thank Professor Ahlmann for the compliment he had paid him by including some of his own records.

Mr. Manley then illustrated with a lantern slide the possible trend of the temperature fluctuations for the period since 1500 in Great Britain. The instrumental records since 1750 could be correlated with Thorarinsson's curve of glacier behaviour. The earlier part of the curve was hypothetical but owed something to J. N. L. Baker's views regarding the climate of the seventeenth century. Assuming that the present "Little Ice Age" had lasted about 500 years, and allowing for the known records of the Alpine glaciers in the fifteenth century, historical geographers might well investigate the events of the sixteenth century with a view to obtaining the earlier half of the curves of glacier behaviour and of temperature. They should seek for some rather sudden development in that century, perhaps between 1560 and 1600. There seemed some reason to believe that glacier advances accompanied groups of relatively severe springs in North-west Europe, as in 1739–45. It was a matter of much interest whether there was likely to be such a sudden development again, perhaps in our lifetime.

With the aid of a second slide Mr. Manley showed that glacier advances could be associated with small groups of rather severe springs when April, May and June in England were prevailingly cold. Mr. Manley thought it tempting to associate with those advances a south-eastward displacement of the arctic convergence, the borderline between the East Greenland current and the northward flow of Atlantic water.

In drawing attention to other temperature curves, Mr. Manley pointed out that while for January the downward trend had become evident in the last decade, there had been a marked upward trend in April and May. The overall tendency was also markedly upwards in September and October.

Mr. Manley hoped that further piecing together of the observations might be effected, so long as it was recognized that caution was needed when using any instrumental records from before 1800. He hoped that one might in time elucidate from the British records what factors had caused the somewhat catastrophic advance of the Norwegian glaciers which Professor Werenskiold

and others had recently dated about 1745, and the associated period of severe and persistent drought in south-east England.

Professor S. W. Wooldridge (King's College, London): I cannot speak of this subject with the detailed knowledge and authority that Mr. Manley has brought to it. At the same time I know many present will agree with me that rarely have we heard a more impressive collocation of evidence.

I am interested to note the increasing dependence on the hypothesis of external solar control. I seem to recall that in Great Britain for about a decade we played the old uniformitarian game of geologists and tried to redistribute the solar capital by geographical monstrosities of various sorts, tampering with the circulation itself, both oceanic and atmospheric, and even taking liberties with the form of the continents. It was only when the reality of recent fluctuations began to dawn on us that we saw plain proof of direct solar control. The notion of solar control is as ancient as speculations on the sun as a variable star. I would venture even to recall that outmoded and unpopular hypothesis by Huntington and Vischer, the solar cyclonic hypothesis, which for the first time, however wrong it was in detail, put the emphasis on the right place.

I would conclude, sir, by putting emphasis where Professor Ahlmann has put it, on the vital importance of these ascertainable facts. Professor Ahlmann rightly imparted a sense of urgency to his words. Here is something manifestly happening, conceivably of great practical importance, in any event, of very great scientific importance. The amassing of evidence from a wide field has impressed on my own mind the difficulties of the work and the very great importance of the result.

Mr. D. J. Schove (St. David's College, Beckenham): I am very interested in the anthology of new charts and information gathered by Professor Ahlmann, which will be invaluable to British students of the subject. It would be useful to know, in view of criticisms of De Geer's absolute chronology, how accurately the Swedish "recurrence levels" and associated climatic changes can be dated in historic time and extended outside Scandinavia.

Perhaps Professor Ahlmann can enlighten us as to the true history of the herring in south-west Sweden. We are usually told that until about 1420 the North Sea herrings frequented south-west Sweden every autumn, and that then the "Herring Revolution" occurred with the result that commercial power passed from the Hanse at Lubeck to the Dutch. Scandinavians recognize that the true history of the herring is more complicated. There was in fact a temporary return to former conditions as late as 1888–97. The attempt of Otto Pettersson to link the return of the herrings with a great sunspot cycle of 111 years does not fit the facts about either herrings or sunspots. It would be interesting to know the results of recent Swedish research.

The climatic amelioration has been reflected since 1931 on the one hand by a remarkable increase of herring on the Murmansk coast and on the other by the disappearance of the industry at, for example, Plymouth. The Cornish pilchard industry however may soon extend into Dorset. Cornwall and Devon are situated at the southern limit of the cold water herring in late autumn and the northern limit of the warm-water pilchard in July–August. The historical geography of these fisheries might lead to interesting curves for comparison with Mr. Manley's temperature graph. Was it the last phase of the Little Ice Age that caused, after many centuries of prosperity (and good years in, for example, 1795, 1814, 1833 and 1847), the failure in the nineteenth century of the pilchards, synchronizing with the failure of Cornish tin and copper?

Mediterranean fish of different kinds in different places seem to have had periods of maximum abundance about 1775 and 1885 (with secondary maxima

in 1840 and 1910) and of minimum abundance about 1830 (with secondary minima in 1850 and 1895). Umberto d'Ancona ('La lotta per l'esistenza,' 1942) gives a mathematical theory of population cycles, but the views of geographers would be stimulating. Historical geographers both in Sweden and in this country may eventually throw considerable light upon the variations of wind and temperature in the past.

Professor AHLMANN: The herring industry in Sweden's eastern waters is a difficult problem because we do not know very much about the fisheries before 1700. We know a little about the migrations of the herring, but the history of the herring fisheries is not sufficiently exact to enable one to base any climatological conclusions on it.

The CHAIRMAN: Time is passing and you will not wish to hear a long speech from me. I would like however to acknowledge the debt we owe to Professor Ahlmann, as I have done before from this platform. He is the prime mover not only in glacial climatology but in every aspect of the study of glaciers and snow and ice. I remember when I started my own work many years ago, I often appealed to him for help, and never in vain. Probably now every young glaciologist wants to ask Professor Ahlmann about his work, and many have been helped and greatly encouraged by him.

The subject Professor Ahlmann has dealt with this evening is extremely intricate and I am astonished at the labour he has expended in collecting such a variety of data from so many different sources. He has collected them, sorted them out and presented them to us in a form equally assimilable to layman and expert. To have done this in a language which is foreign to him is an achievement of which he may well be proud.

THE PROBLEM OF THE GREAT ROSS BARRIER

FRANK DEBENHAM

ON 19 JANUARY 1925 an instructive paper was read to the Society on this subject by Mr. C. S. Wright (now Sir Charles Wright) the ice-physicist on Captain Scott's last expedition, 1910–13. It was published in the *Geographical Journal* for March of that year.[1] The paper itself records the state of our knowledge at that time concerning this stupendous feature of the Antarctic, and it also outlines hypotheses to account for its origin, growth and movement. In the discussion which followed the paper, the present author suggested that the lower part of the great ice-sheet was possibly being increased by freezing and not decreased by melting. The present article may be taken as a continuation of the discussion of 1925, expanding the original suggestion which at that date did not find much support. Since then an immense amount of fresh information has been obtained, almost entirely from the three American expeditions under Admiral Byrd.

Owing to delays in publication of the American results, largely due to the war, very few people in this country yet realize the scope and thoroughness of their scientific work. The Byrd expeditions have, in fact, fulfilled on a grand scale some of the hopes expressed by Wright in his 1925 paper that future expeditions would attack these problems with "well equipped laboratories manned for long periods." They have also added an enormous amount of data from sledge parties, from air-reconnaissance and from seismic soundings, carried out under the supervision of Dr. Laurence M. Gould, Dr. Thomas C. Poulter and Dr. F. Alton Wade, the senior scientists of the three Byrd expeditions of 1928–30, 1933–35 and 1939–41.[2]

The name Ross Barrier, though it was used for the paper of 1925, may be queried by those glaciologists who have adopted the term "shelf-ice," arguing that what was a barrier to Ross's ships when he discovered it has since been used as a highway for sledging. It is still a barrier to ships and it does not seem practicable to change a descriptive name each time we find a way of circumventing an obstacle; at least we must hope that no one will rename the Great Barrier Reef of Queensland because we can now fly over it. In this paper the writer proposes to continue to use the name Ross Barrier for this particular subdivision of the ice types classified as shelf-ice, in preference to the name of Ross Shelf-Ice.[3]

[1] C. S. Wright, "The Ross Barrier and the mechanism of ice movement," *Geogr. J.* 65 (1925) 198–220.

[2] The origin and motion of the Barrier are rightly regarded as such fundamental problems that the National Research Council of the U.S.A. has appointed a committee of experts to investigate the whole subject. The original Committee consisted of Walter Bucher (chairman), Laurence Gould, François Matthes, Paul A. Siple, F. Alton Wade and Max Demorest.

[3] The term "shelf-ice" was coined by Dr. Nordenskjold about 1903 to describe a comparatively narrow band of ice of somewhat similar formation to the Barrier running down the western coast of the Weddell Sea, the relative dimensions of which were approximately those of a wide thin shelf.

It is not proposed to give a long description of the Great Ross Barrier here since there are many and better accounts elsewhere, but it will be as well to convey some kind of a picture for the benefit of the reader who is new to the subject. He must imagine a vast triangular sheet of ice such as would cover the whole of the North Sea from the Straits of Dover to a line joining the Orkney Islands to Bergen. He will get a truer picture still if he will open out North Britain from Norway so that the distance is nearer to 500 miles than 300,

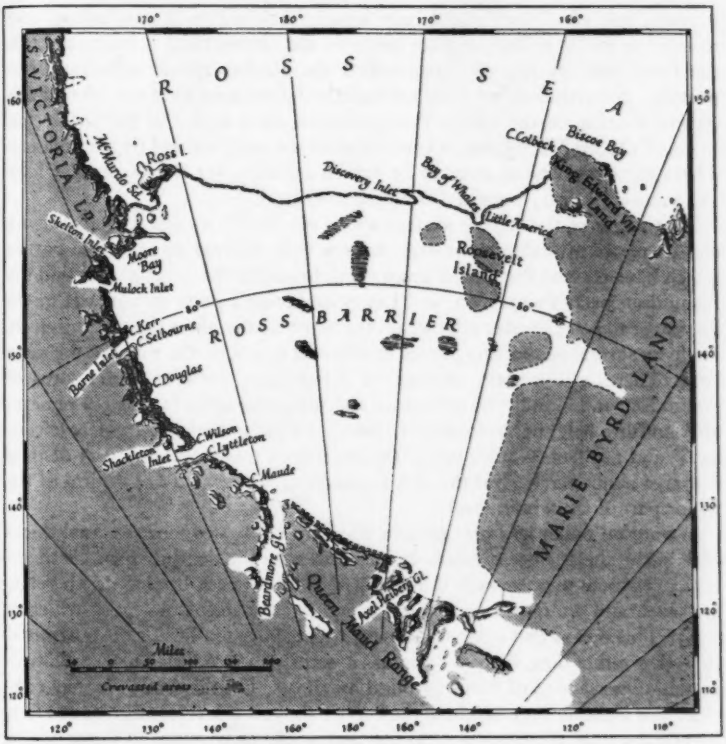


Fig. 1. Great Ross Barrier

and convert Britain itself into a vast ice-capped plateau of an average height of 7000 feet extending as far as Iceland. This particular locality is chosen for comparison because the North Sea was similarly covered with an ice-sheet of these general dimensions in the last Ice Age. Roughly speaking, the actual dimensions are over 400 miles from east to west along the edge of the Barrier facing the Ross Sea, and about 500 miles from this edge to the apex under the Queen Maud Range.

The western boundary is fairly clearly defined by the steep escarpment of the antarctic plateau, down which at least eight major glaciers convey the

overflow of the ice-cap to join the Barrier. The eastern limit is much less easy to define and has given the Americans a great deal of trouble to survey since it is co-terminous with the land ice which completely covers the greater part of Marie Byrd Land, having an average altitude of some 3000 feet. The front edge facing the Ross Sea is therefore the only one which is free and open, and from this great pieces break off each year and float north as flat-topped barrier bergs.

The Barrier may be likened to a vast raft, very thin indeed compared with its area, but very flexible and only loosely attached to the boundary land masses; in fact it is held in place more by the obstructions it meets towards the front than by the moorings which the glaciers appear superficially to provide. Nevertheless, we must not belittle the extraordinary cohesion of this type of floating ice-sheet since there are cases, such as that of the Shackleton Shelf off Queen Mary Land, where the sides are not bounded by land masses. There the obstructions seem to be few in number, yet the sheet is at least 120 miles in length, measured from the mainland.

The height of the Barrier surface above sea-level is clearly a crucial figure and there are available barometric figures from at least three sledge parties which have crossed the Barrier from north to south; the Scott parties and the Amundsen party in 1911–12, and Laurence Gould's party in 1934. It might be proper to place greater reliance on the Scott figures since the readings were made by several supporting parties at different places on the route at the same time. There is a certain amount of discordance between the figures of Amundsen and Gould. Nevertheless, all the figures agree in giving a remarkably uniform height above sea-level, the choice being between 170 feet (Scott, 1911) and 220 feet (Gould, 1933). On the latter's route there is a very definite low area about 82° S., but this is a region of crevasses and not typical of the major part of the whole sheet.[1]

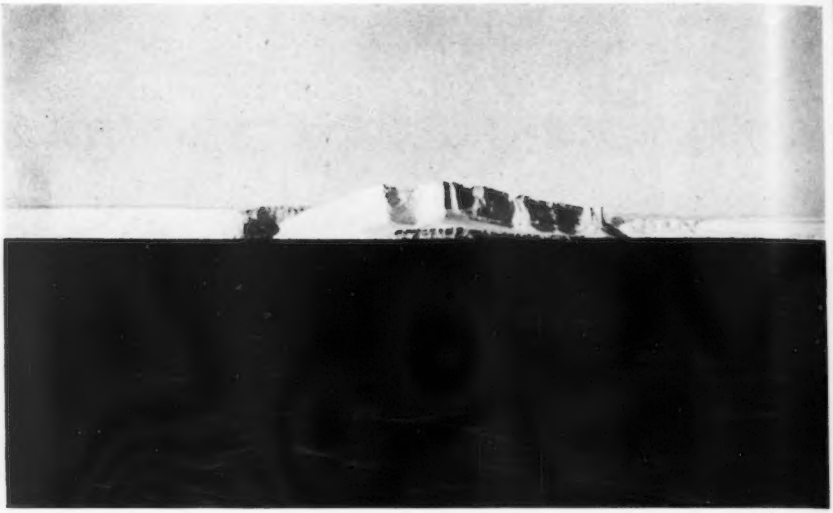
We are on much less sure ground when we try to deduce the actual thickness of the sheet, since the density increases with the depth. There is therefore an element of guesswork in relating height above sea-level to depth below sea-level, and we may as well take Wright's estimate of the ratio, which is 1 : 5. This means that a barrier iceberg x feet above sea-level will go aground in water rather less than x fathoms, a ratio which tallies fairly well with certain observations of bergs aground on shoals. On this basis we may consider that if the average height of the barrier above sea-level is taken as 200 feet, its average total thickness is 1200 feet and it will be aground in water of less than 170 fathoms.

Direct evidence as to the thickness of the Barrier is now due to be published as the result of a truly stupendous programme of seismic soundings carried out by the second Byrd expedition in the vicinity of the Bay of Whales. There is some difficulty in the interpretation of their field observations since the Barrier is not homogeneous and different layers propagate the seismic wave at very different rates. When these difficulties have been surmounted, each of the 500 soundings made will give the thickness of the sheet, and the depth of the water under it where it is afloat. It is significant

[1] There is a full discussion of the barometric heights in G. C. Simpson, 'British Antarctic expedition, 1910–1913. Meteorology,' vol. 1, pp. 286–7, Calcutta, 1919.

1. Edge of McMurdo ice she

Phot. L. Bernac



Phot. R. Skelton

2. Ross Barrier and tilted berg

Phot. C. R. Ford

3. Barrier berg showing change in structure at about 60 feet from upper surface

that the figures for thickness so far published appear to be smaller than expected, which could be due to the lower layers being of much harder ice than has been allowed for in the calculations.

Many hydrographic soundings have been taken from ships along the front of the Barrier and in its bays, and these show that almost everywhere along its face the Barrier is afloat. The height of the front edge has also been measured with care and the average appears to be about 80 feet above sea-level rising to a maximum of 160 feet. In the zone close to the open sea the lower portion must be subject to melting in the summer and heights will therefore be sensibly less than those of the inner barrier. The highest section of 160 feet is over a depth of 300 fathoms, so that it is there separated from the sea bottom by some 1000 feet of water. On account of these early soundings along the Barrier edge it was assumed that the major part of the sheet was afloat, but the American flights have shown that this is far from being the case. They have established that there is obstruction of some kind in a number of places and these have been plotted on the map. In general, an obstruction to the Barrier flow produces pressure waves on the inner side and crevasses round the edge of the obstruction. Where the sheet "unites" again there is much shearing and a reduction of thickness. It is for this reason that the Bay of Whales is a semi-permanent feature, since the Barrier to the south passes over and round a large mass of land, Roosevelt Island, which if exposed would be at least 500 feet above sea-level. The excellent aerial photographs of the American expeditions show clearly that the ice-sheet behaves exactly as a quasi-viscous mass, like a sheet of pitch. Pressure produces waves or rolls and tension produces crevasses, all on the grandest scale (Plate 6).

We must take note here of two kinds of pressure waves which at first sight seem to defy a simple explanation. In the back areas of the Barrier where it is lying against the land, and especially along the western side, there are wide undulations parallel to the land. These waves are often 2 or 3 miles apart, measured from crest to crest, and 40 feet high from crest to trough. Along the zone fronting the Ross Sea there are also rolls, with valleys between, of the same order of size as the inland ones. These run parallel to the front edge and extend inland for 20 or 30 miles, with a "wave length" of 2 or 3 miles. In all these features there is ample evidence that the Barrier is moving and we must now review what we know as to its rate and direction of motion.

We have one measurement which is entirely trustworthy and direct. In Captain Scott's first expedition a depot was laid, in 1902, on the Barrier surface some 10 miles out from Minna Bluff, and on a direction line given by two sharp mountain peaks on the land. Thirteen months later a visiting party under Lieutenant Barne found that the depot had moved 608 yards to the north-north-east. Five and a half years later it was again visited, by a Shackleton party, and found to have moved at a rate of nearly 500 yards per year since it was laid down, or about 4 feet per day. This rate is much greater than that of any antarctic land glacier yet measured. For example, over a period of six months the Ferrar glacier moved at a rate of less than 2 inches per day, while the Barne glacier on Mount Erebus moved still more slowly. On the other hand, a floating glacier tongue at Granite Harbour was moving, in a summer month, at the rate of 2·8 feet per day.

A much less direct measurement of the rate of Barrier movement is to be deduced from the survey of the front edge made in 1902 by the *Discovery* compared with another made in 1911 by the *Terra Nova*. A section of these surveys is given in Fig. 2, showing that in places the edge of 1911 is in front of that of 1902, from which we can assume a *minimum movement* of that amount in the interval.[1] The figures are very interesting since they show that at places on the free edge there are rates of motion up to 15 feet per day; that is, nearly four times the rate of the same sheet off Minna Bluff, which is about 100 miles from the front edge. It is clear that we are dealing with a form of flow which varies in different parts of the ice-sheet and seems to increase rapidly towards the free edge.

We must now consider where the ice comes from to form this vast sheet. Wright has made it clear in his paper that only a fraction of it comes from the

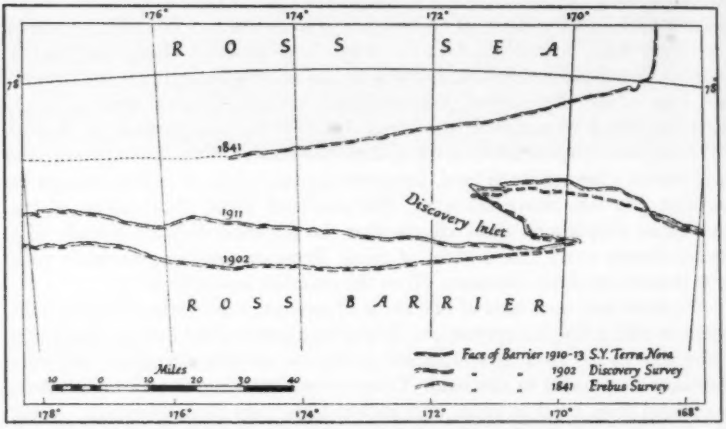


Fig. 2. Central sector of Barrier front

land; he considers perhaps one-third of it, a higher figure than the present writer would be inclined to allow, but the exact fraction is not of major importance. Its net increase by snow falling on its surface is clearly a factor of great interest, and again we are indebted to the acumen of the Shackleton men, Joyce and Macintosh, who found the Minna Bluff depot in 1908 and measured not only its movement but the net annual increase of the surface snow. This worked out at 15 inches of snow per year of a density of 0·5. The snowfall is not likely to be uniform over the whole of the Barrier, nor is the ablation (evaporation), so this single measurement must be used with caution. The annual increments appear to be greater in the Bay of Whales region, judging from measurements made by the Norwegians and the Americans, and there are indications that the increments must be considerably less towards the land in the southern region, either because the snowfall is less or

[1] A full account of these measurements is given in F. Debenham, 'British (*Terra Nova*) Antarctic expedition, 1910–1913. Report on the maps and surveys,' London, 1923.

because of heavy ablation due to the descending dry winds from the plateau. For the sake or argument we might take an average figure for the whole Barrier of the order of 1 foot of snow (density 0·5) added per year.

We have now set out an array of phenomena all of which require explanation and they may be restated as follows. We have the curiously uniform thickness of the sheet with an upper limit of the order of 1200 feet, whereas ice caps on land have been measured by geophysical methods to as much as 6000 feet in depth. We have the rate of motion which is not only greater than that of glaciers in the same region but varies over a wide range, increasing rapidly towards the free edge. As a consequence of this motion we have pressure waves against the enclosing land, both against obstacles in front of it and against the continental mass behind. We have thinning out where it presses in between islands like those of the Ross Island archipelago, and we have a certain number of places where the sheet is definitely aground and moving over low masses of land which may even be above sea-level.

It was during a lecture on the Barrier given by Captain Scott in his headquarters at Cape Evans on 7 June 1911 that the writer first heard the basic hypothesis which goes far to explain these phenomena, or such of them as were known at that date. The lecturer said that Dr. G. C. Simpson, our meteorological officer (now Sir George Simpson, K.C.B., F.R.S.), had suggested to him that the Barrier was "expanding under its own weight." Other terms used were "spreading," "flattening" and even "slumping," but in essence they describe the process of differential movement now usually called "extrusion flow" or "creep."

As a rough analogy we may think of what would happen if we placed a sheet of pitch or bitumen on a fluid which floated it with about one-sixth of its mass above the surface. It would gradually spread out in all directions at a rate dependent chiefly upon the temperature. If we varied the experiment in such a way that the sheet could spread freely only in one direction, we should find that it would press against the restraining walls (and possibly cause minute pressure rolls), and that it would have a differential rate of motion in the direction of the free edge, greatest at the edge itself. If we imitated nature still further by placing small obstructions in its path, we should find that the pitch behaved very much as does the ice-sheet, even to pressure ridges and crevasses if the amount of pitch and the temperature were suitably controlled. The analogy is somewhat artificial since the actual mechanism of flow is probably quite different in the two cases, and we must not pursue it too far. Nevertheless, the rate of spreading of the ice-sheet will depend, as with the pitch, on the temperature of the mass and on the stress applied, that is to say on the weight of the ice compressing itself.

Experiments made during the war on a mixture of ice and wood pulp (4 per cent. of wood) known as "pykrete" have given us reliable figures for what physicists call the "creep" of this mixture under varying factors of temperature and stress. There are as yet no satisfactory data for ice alone, still less for the mixture, ranging from snow to hard ice, typical of such a formation as the Ross Barrier. Nevertheless, estimates of the minimum depth of névé necessary to produce continuous extrusion flow on land have been made with some confidence by various fieldworkers, particularly Dr. Demorest,

who placed it at about 130 feet for temperatures near the freezing point. It may or may not be significant that in barrier icebergs high enough to cover this range, the stratification of the snow layers seems to disappear at about 100 feet or less from the upper surface (Plate 3). The uniformity with which the upper layer of stratification ceases at from 60 to 100 feet from the top, as shown by the depth of the conchoidal fractures seen in freshly-calved bergs, is at least striking. At whatever depth the flow takes place it is clear that there must be some sort of equilibrium between the rate of motion forward and the additions to the upper surface which keeps the total thickness below a limiting value.

So far we have been ignoring the under-surface of the sheet, concerning which we know very little but which is just as important as the upper surface, and, indeed, may either lose ice by melting or gain it by freezing.

It has been almost universally assumed that there must be loss by melting underneath the sheet. This was a natural deduction when, in the early days, it was believed that the Barrier moved very slowly, since without melting from below, the annual accretion of surface snow would finally ground the Barrier everywhere and vary its height widely. But as soon as we acknowledge that the mass is moving by virtue of its own weight spreading it outwards, there is no need to assume melting underneath since equilibrium can be arrived at equally well whether it grows from above or below or both at the same time. We will see later that the real difficulty in assuming either freezing or melting at the base of the sheet is to find a means of disposing of heat, either by conduction through the ice or by convection through circulating water.

On the whole we know so little about the physical state of the water under the Barrier that the present writer feels we cannot safely apply any equations to prove either melting or freezing. The alternative is to seek evidence from smaller sheets of ice than the Barrier, studying their natural development and judging how far this may be applicable. We must not assume similitude but at the same time we may be permitted to expect it unless we have definite proof to the contrary. In other words, we must be ready to admit the entrance of a new factor due to nothing but size but we need not conjure it up from equations based on doubtful quantities.

Let us begin with the smallest and commonest example of floating ice, namely sea ice, as it forms each year in the sheltered bays of the antarctic continent. The natural history of sea ice is admirably described by Wright and Priestley in their monograph on antarctic glaciology, and by Wordie.[1]

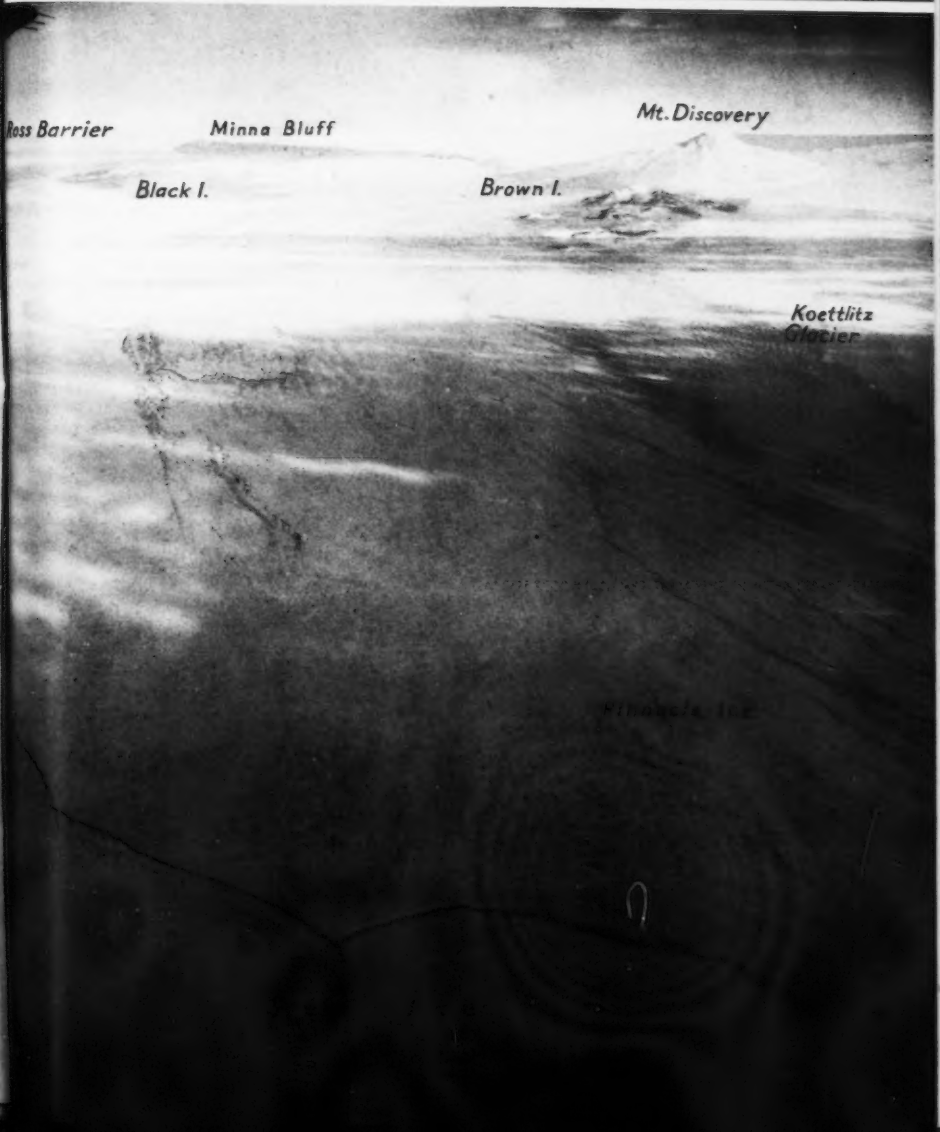
In a protected bay in the Ross Sea area the sea ice grows rapidly up to some 3 feet in thickness in the first month or so of winter, after which its covering of snow, and possibly other factors, appear to diminish its rate of growth until the last months of winter and early months of spring when its rate increases again, and from 7 to 8 feet of ice are formed by the time high summer is reached. If there is a strong circulation of the sea water under the ice it will then melt through completely. But the important point is that unless there is such a circulation it does not melt very much and by late

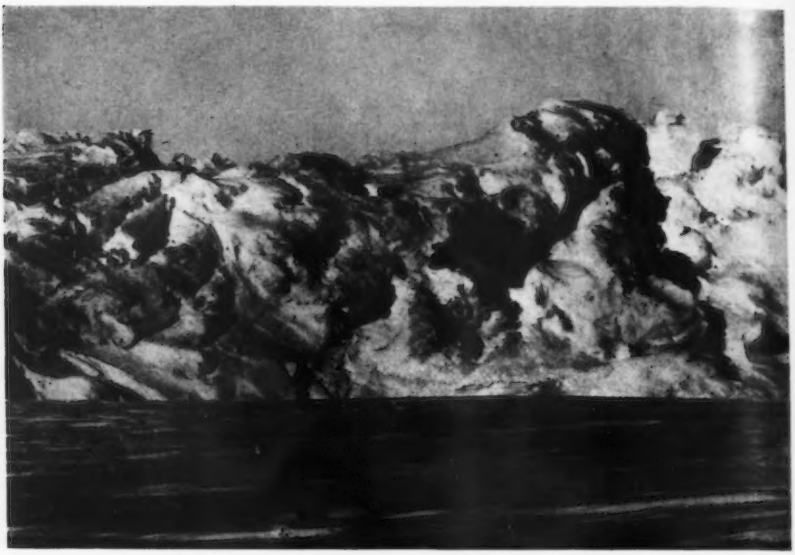
[1] C. S. Wright and R. E. Priestley, 'British (*Terra Nova*) Antarctic expedition, 1910–1913. Glaciology,' London, 1922; J. M. Wordie, "The natural history of pack ice in the Weddell Sea," *Trans. Roy. Soc. Edinb.*, 52 (1921) 795–829.

4, 5. McMurdo ice sheet: above, western sect
below, eastern se

Phots. by courtesy U.S. Navy Dept., Washi

Ross Barrier
Mt. Discovery
Mt. Morning
Brown I.
Koettlitz Glacier
Western Mts.
Sea Ice


Ross Barrier
Minna Bluff
Mt. Discovery
Black I.
Brown I.
Koettlitz Glacier



Phot. C. Royds

6. Pressure ridge in Ross Barrier near Cape Crozier

Phot. R. Skelton

7. Headless fish harpooned in McMurdo Sound

autumn it is still of considerable thickness, ready to increase again in the winter. The classic example is that of the ice which surrounded the *Discovery* in her winter quarters in 1902, for it neither melted nor broke up and the ship was compelled to spend another winter in its grip. At the end of the first year it was about 8 feet thick and at the end of the second 12 to 14 feet thick. Probably at least 2 feet of this thickness was due to snow.

There are better examples still in the Bay of Whales of two-year-old, three-year-old and even older sea ice which can be clearly identified in the Byrd aerial photographs and will no doubt be fully described in their scientific memoirs. It even seems likely that parts of the "Little America" headquarters were built close to what in Amundsen's day (1911–12) was young sea ice but which in the intervening eighteen years had grown till it reached a height of some 20 feet above sea-level. Dismissing that particular example as unproven, there is clear evidence of sea ice which is over 30 feet in total thickness in other parts of the Bay of Whales. There is a good illustration of this old sea ice in Admiral Byrd's book 'Antarctic discovery,'[1] showing that the 7 or 8 feet above the water level are almost entirely snow, clearly stratified and looking very much like a miniature Barrier.

A large stretch of moderately thick ice which was indeed described in these terms was first seen by Captain Scott in the *Discovery* in 1902 when he penetrated to Biscoe Bay, beyond the eastern end of the Barrier. He describes it as follows:[2] ". . . we could see that the fast ice on our right was no longer plain sea-ice; at the edge it stood seven or eight feet above the water, and seemed to rise to fifteen feet or more on the slope of the cornice . . . it was too thick to be considered sea-ice, and yet was far thinner than any land ice or barrier formation that we saw elsewhere."

This bay, which farther in towards the land is called Sulzberger Bay by the Americans, is now fairly well known both from the air and from the ground, and the sheet is described in the preliminary reports as being shelf-ice with a much thinner sheet than that of the Ross Barrier. It is checked and held in by many ice-covered islands. Until more of the American results are published it is difficult to say whether the ice described by Scott was very old sea ice or thin barrier ice, if indeed they are not much the same thing.

In the foregoing examples of ice-sheets afloat we have no certain proof, except in the case of the two-year-old sea ice, that the sheets have grown thicker by freezing from below. So we now turn to an example where there can be no doubt about it and where there is an annual net loss to the upper surface by thaw instead of net gain as on the Barrier itself.

Along the western shores of the Ross Sea there are many localities where the snow which falls each winter entirely disappears in the succeeding summer. The chief reason for this reversal of the state of affairs on the main Barrier and at its eastern end is the existence of a föhn effect in the winds from the adjacent high plateau of Victoria Land. These comparatively dry katabatic winds pour down over the escarpment, particularly during the winter, and ablate the snow so effectively that only the major overflow glaciers from the plateau reach the sea. The minor glaciers with only a local supply occupy

[1] Richard E. Byrd, 'Antarctic discovery,' pl. facing 57, London, 1936.
[2] R. F. Scott, 'The voyage of the *Discovery*,' vol. 1, pp. 183-4, London, 1905.

"dry" valleys, bare of snow in summer, and their blunt, wall-faced snouts end many miles from the sea. In the week or so of high summer the surface thaw on ice near sea-level is prodigious, and it is increased in the region of McMurdo Sound by the dark volcanic dust scattered over the ice by the wind.

The most conclusive proof of this somewhat startling reversal is given by the ice-sheet which fills the southern end of McMurdo Sound (Fig. 3 and

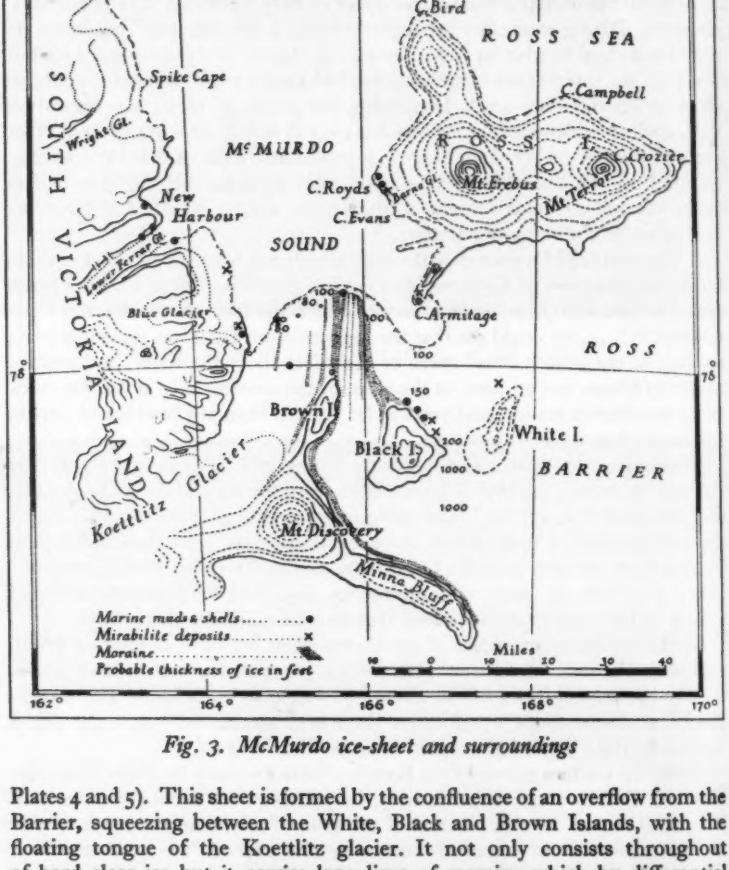


Fig. 3. McMurdo ice-sheet and surroundings

Plates 4 and 5). This sheet is formed by the confluence of an overflow from the Barrier, squeezing between the White, Black and Brown Islands, with the floating tongue of the Koettlitz glacier. It not only consists throughout of hard clear ice but it carries long lines of moraine which by differential thaw have turned the central part of it into pinnacled ice, the name by which the men of the *Discovery* knew it. Instead of the annual accretion of a foot of snow found only 30 or 40 miles away off Minna Bluff, this sheet has a net loss from the surface, otherwise the moraines would not be visible. At the northern edge, a few hundred yards from the actual front, its total thickness is about

120 feet, and it does not appear to be very much thicker 20 miles farther in by Black Island. The moraines show that the sheet is moving, probably rather slowly, and it should therefore thin to a wedge owing to its surface loss; yet this does not appear to be the case in any significant degree, a phenomenon which supplies the first hint that there must be some compensating increase from below by freezing.

There happen to be much clearer proofs that this does take place, in the form of certain deposits on the surface of this sheet, and these we must now describe in some detail although they have been recorded fully before.[1] In brief, these deposits were of two types: (1) Shallow deposits of sea-bottom muds lying more or less undisturbed on the surface of the ice up to 20 miles from the edge of the sheet. Associated with these muds were shells, fragile single corals and siliceous sponges often in the position of growth. Sponge spicules in the surface ice were so common that it was almost impossible to find ice for cooking which was free from them. (2) Patches of the mineral mirabilite (sodium sulphate) up to many hundredweights in quantity, often perfectly pure and resting on clear ice. These deposits and the means by which

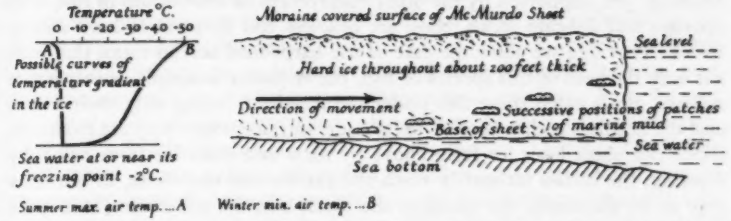

Temperature °C.
0 -10 -20 -30 -40 -50
A
B
Possible curves of temperature gradient in the ice
Sea water at or near its freezing point -2°C.
Summer max. air temp. ...A
Winter min. air temp. ...B
Moraine covered surface of McMurdo Sheet
Sea level
Hard ice throughout about 200 feet thick
Direction of movement
Successive positions of patches of marine mud
Base of sheet
Sea water
Sea bottom

Fig. 4. Section through McMurdo ice-sheet illustrating theory of origin of raised marine muds

they have reached their strange resting place are fully discussed in the paper already quoted, and here we may concentrate on a still stranger "deposit" which proves the same point though sounding more like fiction.

When Captain Scott first penetrated McMurdo Sound he landed on the pinnacled ice, of which he wrote,[2] "Its formation is most peculiar. The surface is covered with numerous spiky pinnacles and ridges many feet in height . . . the ice between the pinnacles was covered with a thick deposit of volcanic sand. . . . We found on the ice the skeleton of a fish eighteen inches in length, probably carried here by a seal." The fish was without its head.

In the early spring the seamen of the *Discovery* used to secure meat for the ship's larder by waiting at the breathing holes of seals and harpooning them. On one occasion a seaman called for help and with much difficulty five men hauled out a seal harpooned in the shoulder. Amidst the ridicule of his companions the harpooner declared that he had thrust his weapon at a huge fish, not at a seal. The laugh was on the hunter's side however when, searching among the broken ice covering the water in the seal hole, they recovered the

[1] F. Debenham, "A new mode of transportation by ice," *Q. J. Geol. Soc. Lond.*, 75 (1920) 51–76.

[2] Scott, *op. cit.*, vol. 1, pp. 208–9.

headless body of a fish weighing 40 pounds and measuring 46 inches in length in its mutilated state (Plate 7). It is believed that this is the only specimen of this fish ever caught and for lack of its head the scientists have been unable to classify it.

The next appearance was in their last sledging season of 1903 when Dr. Wilson with two companions made a short journey up the Koettlitz glacier, which also has pinnacle ice. His diary of this journey, recently bequeathed to the Scott Polar Research Institute, has this entry concerning the fish: "All this old pinnacle ice was strewed with wind-blown sea-wrack as well as with stones and gravel, glacier-borne. We found from time to time shells, sponges and dead fish, even the largest Notothenias—4 feet long—always without a head. Three of these fish we found, but not one had a head."

Unaware of these strange findings a party under Griffith Taylor in 1911, again on the floating part of the Koettlitz glacier and about 5 miles from its seaward end, found yet another of these large fish. Its body was headless, about 20 inches long and much decomposed, lying upon perfectly clear ice.

It seems an odd set of circumstances on which to hang a theory as to freezing; yet, supported by the other occurrences of sea-bottom *in situ*, with sponges and delicate corals, these six headless fish do seem to have a story to tell. Provided we allow the case of the harpooned seal to mean that seals eat only the head of this species of fish, the sequence is simple, somewhat as follows. Seals catch these fish under the ice-sheet, eating only their heads, and the headless bodies float up to its under-surface where they are frozen in. Since this sheet loses ice from above by thaw and gains ice from below by freezing, the bodies ultimately reach the surface and stay there, in the same way as do the muds, the sponges, the corals and the mirabilite. It is quite certain that no bird could carry a 30-lb. fish 5 miles from the sea, and it seems equally certain that seals would not carry them either. Perhaps the strangest part of the story is that the only two sledge parties which have crossed that floating glacier have stumbled on no less than four of these headless fish, as though there were hundreds in the parts not traversed.

The explanation put forward to account for the sponges and shells is dull by comparison. It is that where the sheet is very close to the sea floor a winter's freezing will enclose patches of the bottom, probably with the flexible mesh of ice crystals known as *frazil* ice. In the succeeding summer the superficial loss by thaw causes the sheet to rise off the bottom carrying the deposit with it. Owing to repeated freezing from below and thawing above, the deposit must ultimately reach the top.

The case of the mirabilite is more puzzling yet at the same time more conclusive. When sea water is concentrated to a brine at a low temperature (about −8° C.) sodium sulphate is crystallized out. This happens in a hard winter in the Great Salt Lake of Utah, U.S.A. In the case of the McMurdo Sound sheet we may postulate uneven portions of the sea bottom where the ice may pass over depressions and cut them off from the main body of the water. Freezing would then concentrate this local body of water to the point of crystallization, the crystals of salt being entangled in a mesh of ice crystals to begin their curious journey to the top of the sheet.

It is only fair to say that this explanation of the raised marine deposits has

not attracted much attention or received general support; chiefly, it is supposed, on account of the unusual premise it requires, namely, additions by freezing to the underside of a sheet of ice up to 100 feet or more in thickness. Moreover, this particular sheet of ice is in a position where one would expect a considerable circulation of sea water under it, since a current is known to pass round the southern end of Ross Island between it and White Island.

Hesitation to accept it is also due, no doubt, to the prevalent impression that the physical state of affairs under very thick sheets could not allow freezing to take place to any substantial degree. This impression is widespread in spite of the fact that it involves a reversal of the well-known process of sea ice formation. Indeed, to uphold such a reversal, we must postulate that sea ice has a limiting thickness beyond which melting from below must inevitably occur. The case of the McMurdo ice-sheet is therefore a critical one, for if freezing occurs under a sheet of that thickness in a moderately exposed position, it is even more probable under the remote parts of the Barrier where the water must be much more stagnant. We should therefore now turn our attention to the physical requirements for the change of state from water to ice and the reverse in such a situation.

The real difficulty is to find a way in which the latent heat of fusion can be led away from the junction of the lower surface of the sheet-ice and the water in which it is floating, for unless it is disposed of no change of state can take place. For an apt if somewhat homely illustration of this latent heat, we may consider the case of a polar traveller making a cup of tea on his Primus stove. If he can find some fresh water on the ice, a fraction above freezing point, it will take a certain amount of paraffin to boil it for his tea. If there is no water and he has to use the same quantity of ice at freezing point, it will take nearly twice as much fuel to make his tea. The extra heat provided has been "hidden" in turning the ice into water, and it is called "latent" because it does not appear as a rise in temperature of the mass. Similarly for the reverse change of state; if the water is to change back again into ice a rather impressive amount of heat has to be led away, namely the latent heat locked up in the water in its fluid state.

The above way of describing the change of state will hardly satisfy the strict physicist but it will serve our purpose, which is to show that there can be neither melting nor freezing underneath the Barrier without transferring heat away from the point where the change is to take place. Thus if the temperature of the ice-sheet is well below freezing point, heat can escape upwards by conduction and permit some water to freeze. If the water is definitely above freezing point and is circulating then it can transfer the heat required for melting.

We do not know very much about the temperature conditions under the Barrier or the McMurdo sheet, but what we do know is important (Fig. 5). In mid-winter, for instance, the water must be very close to the freezing point of sea water, about −2° C. On the upper surface of the sheet the mean temperature will be very low, well below −20° C., and occasionally dropping to −50° C. or lower for long periods.

There will therefore be a temperature difference distributed somehow through the sheet. The American scientists have paid a good deal of attention

to this gradient and in due course we shall read the full interpretation of their measurements. In the meantime we may quote certain significant tendencies in their figures.[1] One of these is that the temperature at about 50 feet beneath the upper surface appears to be steady at the annual mean temperature of the air, which was −24° C. This means that the higher summer temperatures of the air do not affect the temperature gradient with which we are concerned below the first 50 feet. This figure was derived from a boring made where the sheet was 450 feet thick and the measurements were pursued to a total depth of about 135 feet (a depth below sea-level in that locality) at which the temperature was fairly steady for ten months at −22° C. This figure gives us a temperature difference of about 20° C. to be

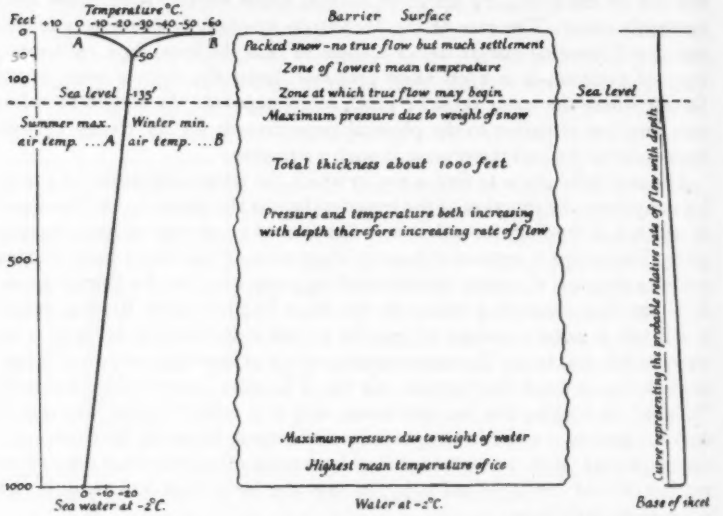

Temperature °C.
Feet +10 0 -10 -20 -30 -40 -50 -60
0
50
100
A
B
50'
Sea level
135'
Summer max. air temp. ...A
Winter min. air temp. ...B
500
1000
0 -10 -20
Sea water at -2°C.
Barrier Surface
Packed snow - no true flow but much settlement
Zone of lowest mean temperature
Zone at which true flow may begin
Sea level
Maximum pressure due to weight of snow
Total thickness about 1000 feet
Pressure and temperature both increasing with depth therefore increasing rate of flow
Maximum pressure due to weight of water
Highest mean temperature of ice
Water at -2°C.
Curve representing the probable relative rate of flow with depth
Base of sheet

Fig. 5. Temperature and pressure distribution in Ross Barrier

distributed through about 300 feet of the ice-sheet, that is, between the deepest point reached and the base of the sheet. What form of curve that distribution will provide we do not yet know, but it does give a strong indication that the physical conditions are such as to permit the conduction of the latent heat of freezing at the base into the cold higher layers of the sheet. Additions from below by freezing may therefore occur. On the other hand, to provide conditions for melting at the base of the sheet, the sea water must be above −2° C. and must be circulating.

Now as far as the possibility of a constant circulation of water under the Barrier is concerned the aerial reconnaissances of Byrd's men have given valuable information. Before their discoveries of a number of places in the

[1] Major F. Alton Wade, "The physical aspects of the Ross Shelf ice" in 'Reports on scientific results of the United States Antarctic Service expedition, 1939–1941,' *Proc. Amer. Philosoph. Soc.*, vol. 89, no. 1 (1945), pp. 160–73.

Barrier which are aground the general belief was that it was almost entirely afloat. Even if it had been it would be difficult to imagine any circulation on a grand scale penetrating over 400 miles under the ice-sheet, but now that we know there are many obstructions to such circulation we are bound to consider it as liable to be very slight or very local.

If that be so then we may imagine the following curious set of circumstances in the rearward areas of the Barrier. The upper third of its 1000 feet or more of thickness is at a steady temperature of about −20° C. and it is floating on comparatively still sea water which is at a temperature near freezing point. Freezing should then take place at a rate dependent on the steepness of the temperature gradient in the mass and its capacity for conduction of heat. This increase of ice from below, together with additions from above by snowfall, must be in general equilibrium with the rate of motion of the ice-sheet towards the front edge. The steady increase in salinity of the water underneath the sheet will be relieved by a slow circulation, of the nature of a drift, the heavier salter water tending to slip out under a counter drift of fresher water from the open sea. It might be possible to detect this drift by means of a series of salinity soundings at the free edge.

Assuming some such state of affairs we may now examine the effects of such a double-sided increment and decide what sort of proofs should be sought in future to sustain the hypothesis. As already mentioned, there is no difficulty over the uniformity of thickness since an equilibrium between thickness and rate of spreading will be arrived at whatever the mode of accretion. It is clear that the Barrier, under the suggested method of growth, may be doing exactly what the McMurdo Sound sheet has done, namely picking up bottom material where it is aground or nearly so. Such a deposit should be discoverable some day in an overturned barrier berg as an inclusion towards its base. Unfortunately, barrier bergs do not readily overturn, nor is it at all easy to examine one closely, but if ever muds containing some marine material are collected from such an iceberg the proof will be there. Biologists may query the likelihood of marine life so far under a sheet, in which case some other evidence as to its being a piece of the sea-bottom will have to be sought. It will, of course, be useless to expect any kind of a dividing line between the original névé turned into ice and the original frozen sea water. Even if there were special features in either they would have been destroyed or merged under the influence of the extraordinarily rapid movement in the middle and lower zones where no doubt the line of division must have been.

It will be realized that the spreading of ice under its own weight involves some degree of differential movement within the mass, the maximum rate being presumably at or near the base. The upper zone of compressed snow does not move by its own weight but is carried by the lower zone which is moving under the greater pressure at that depth. If this is so one would expect to find small crevasses or some other surface evidence in the more rigid snow zone carried by the more plastic ice zone. That these have not been observed may well be due to the fact that drifting snow is the rule all over the Barrier surface except on the rare calm days, and it would fill up the cracks almost as fast as they were formed. On the other hand, in a large barrier berg

there must be a similar spreading motion in all directions, and as it has no steady source of drift-snow such crevasses, if formed, should be apparent. It is rather characteristic of old icebergs, especially of those which have gone aground, to have a fractured upper surface with crevasses forming either a square or a diamond pattern. These are very apparent in the aerial photographs taken in Sulzberger Bay, the home of stranded bergs. Probably the tensions in two directions responsible for the pattern occurred, in this iocality, when the ice was leaving the broad valleys down which the plateau Ice-cap moves, but the crevasses on the bergs seem to be wider than in the land ice. It is suggested therefore that the spreading in all directions of the plastic part of an iceberg increases, if it does not originate, this striking feature of crossed crevasses.

The fact that the stratified upper part of a barrier berg terminates rather suddenly at from 30 to 60 feet from the top is well shown in photographs of tilted icebergs. Where the tilting is extreme, parts of the stratified zone, or even all of it, can be seen to have slid off leaving a more or less plane surface.

The question of cracks in the upper surface of barrier ice leads us to refer again to the curious waves near the seaward edge which are more of the nature of long continuous rolls parallel to the Barrier front with rather steep and deep valleys separating them, 2 or 3 miles apart. The American scientists call these valleys "hinge lines" and say that they are always present where the Barrier is freely afloat. The name hints at the operation of the tide, and it must be admitted that the vast ice-sheet may act somewhat like a thick scum or fragile skin over the water and operate as a damper to the tidal wave. It is possible, therefore, that these valleys are "hinge lines" or "yield lines" to the lift of the small tides of the Ross Sea. That explanation is not entirely satisfactory since the valleys look more like wide rifts which have been smoothed out by later snowfall. On the other hand both their direction and their symmetry seem to indicate a factor operating with regularity from seaward, which fits the tidal wave.

The following suggestion is put forward to explain the valley-like appearance of these hinge lines. Let us accept the postulate that they began as a narrow crack from top to bottom of the sheet caused by the tides (Fig. 6). Once formed, this crack will be filled with sea water pressed up immediately from the base, but freezing very quickly since the temperature in the sheet is very low. This sea ice will to some extent seal the crack but it will remain a line of weakness, especially as the salt in it makes it flexible. The crack will therefore continue to open and admit more sea water to be frozen in its turn. The ice will naturally form only up to sea-level; above will be an open crack which, however, will be filled with drift snow and will produce a rift- or valley-like appearance.

This process must be going on wherever there are cracks from base to top and therefore must occur in any area of fracture where the sheet is afloat. Evidence on this point will no doubt be forthcoming in due course, but reference may here be made to the "haycocks" which usually accompany belts of heavy and active pressure. As the name indicates they are domes of ice on the surface, thick at the base and thin or even open at the top, often but not always occurring in lines. These would seem to be the "breathing holes,"

so to speak, of the comparatively warm water exposed by the cracks, forming in winter and dissipating or being covered up in the summer. The sea water is forced up to within 100 feet or so of the surface, to sea-level, and even as it is freezing gives off some vapour. Most of this vapour will immediately form as rime on the sides of the crack, but some will reach the surface where in winter it will meet air even colder than the ice. The rime will therefore be thicker at the surface than elsewhere, and in most places will bridge the crack. Where it is wider or where it makes an angle the bridging will take the form of a dome or haycock. It will occur to the reader that this process provides an alternative explanation of the mirabilite deposits mentioned above as common in the McMurdo Sound region. The sea water which is admitted up any crack from the base provides the brine from which selective crystallization takes place, the more soluble salts draining away through the porous ice as they do in the case of old sea ice.

We need to know much more about the fundamental data which at present

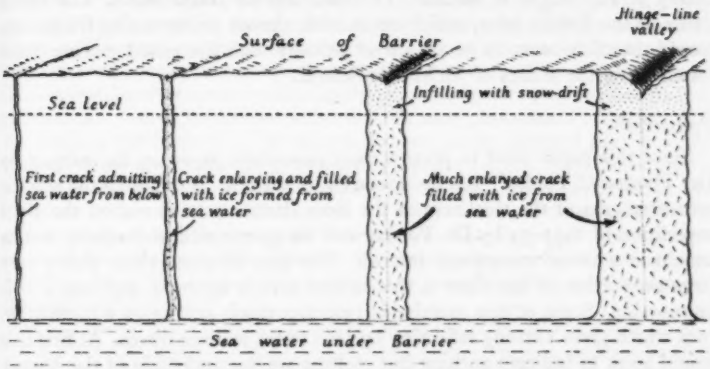

Hinge-line valley
Surface of Barrier
Sea level
Infilling with snow-drift
First crack admitting sea water from below
Crack enlarging and filled with ice formed from sea water
Much enlarged crack filled with ice from sea water
Sea water under Barrier

Fig. 6. Hypothetical development of hinge line valleys

we must extrapolate or assume in order to provide some foundation for this hypothesis of freezing increments to all floating ice-sheets. Of these fundamentals probably the most important is the temperature of the water beneath the Barrier. How to obtain such temperatures will provide a problem for the polar scientist for some time to come. The temperature under smaller sheets, such as that in McMurdo Sound, is not quite so unattainable since there is some circulation there and it is not quite impracticable to consider boring right through it. The next most important observation would be as to the circulation of sea water under the Barrier.

The reason for the importance of such measurements is that we might then apply the laws of physics with comparative certainty. We may restate the case in this way. We know that the mean temperature of the Barrier is well below freezing point and that seasonal variations do not penetrate deeper than 50 feet from the surface. Consequently, if melting is to take place at the under surface the temperature of the sea water must be above −2° C., how much above depending on the rate of circulation. Where there is a strong current

under the sheet, melting can take place in water only a fraction of a degree higher than the freezing point for the salinity of the water concerned. We may note in passing that for sea water of average salinity, 35 per thousand, the freezing point is −1·9° C. In winter the temperature of the surface water in the Ross Sea, down to about 100 fathoms, is more or less uniformly −1·9° C.; but there is need for more observations. We must remember too that the maximum density of sea water is at a temperature below its freezing point so that water being cooled by contact with the under surface of the sheet remains there and does not sink as it would if it were fresh.

In conclusion we may suggest that there is a close analogy between the Ross Barrier of the present day and the ice-sheets which covered the North Sea and the Irish Sea during much of the Pleistocene Ice Age. If the hypothesis of basal freezing is correct these sheets should have been collecting marine muds and shells just as the McMurdo sheet appears to be doing now. Where the sheets pushed over the land these marine deposits would be left finally at any height or distance to which the ice could reach. The shelly drifts of the British Isles, which occur with almost embarrassing frequency, would therefore seem to be the direct analogy with the raised marine muds found along the shores of McMurdo Sound.

Postscript

Since this paper went to press a most important paper on the subject by Dr. Thomas C. Poulter [1] has been seen by the author. It concerns the seismic measurements of the thickness of the Ross Barrier carried out on the Byrd expedition of 1933–35 by Dr. Poulter and his geophysical colleagues, and its conclusions are of exceptional interest. The data obtained show that a very large proportion of the sheet in this eastern area is aground, and much of it on moraine. Some of this moraine is 1500 feet thick, resting on a foundation rock which gives a strong reflecting horizon to the seismic waves. At first this would seem to indicate nothing but melting on the underside of the Barrier ice, yet it introduces another puzzle in that the sea ice in the southern part of the Bay of Whales goes on freezing up to a thickness of at least 50 feet. It is not easy to account for freezing in surface waters and melting in deeper waters at the same time, and clearly, as Dr. Poulter says, "many more seismic stations will have to be occupied before a complete picture is obtained." His paper contains a wealth of detail on other matters such as the currents under the ice, the density of the ice and the hinge lines or tide cracks. The present author feels that he owes an apology both to Dr. Poulter and to the Society for not having seen this paper before writing his own. As forecast in the opening remarks of the latter, the geophysical work of the American scientists is of exceptional value and the data they have provided on this subject constitute the greatest contribution yet made towards a final solution of the problem of the origin of these vast sheets of ice.

[1] Thomas C. Poulter, "Seismic measurements on the Ross Shelf Ice," *Trans. Am. Geophys. Union*, 28 (1947) 162–70, 367–84.

The above paper was read at the Afternoon Meeting of the Society on 25 October 1948.

DISCUSSION

Before the paper the CHAIRMAN (Mr. J. M. WORDIE) said: Professor Debenham needs no introduction to an audience of the Royal Geographical Society. It gives me much pleasure to see him here to revive memories of Scott's great expedition and the discoveries he made on the Ross Barrier. Professor Debenham is now, I believe, able to bring the problem up to date from data obtained by the American expeditions under Admiral Byrd.

Professor Debenham then read his paper.

SIR GEORGE SIMPSON: Professor Debenham's address indicates that there is a battle royal between those who advocate that melting is the chief process which takes place under the Barrier sheet and those, led by Professor Debenham, who say that freezing predominates. We might call them the freezers and the melters. In trying to solve the problem Professor Debenham first gives a useful account of the physical processes involved. He, however, comes to the conclusion that there are so many variables that physics can give no satisfactory solution. He sums up his conclusion in this regard in the following words: "On the whole we know so little about the physical state of the water under the Barrier that I feel we cannot safely apply any equations to prove either melting or freezing." There you have a geographer accusing physicists of being unable to do anything with equations; he throws physics on one side and goes on to his own theory of the method by which marine deposits come to be found on the surface of sea ice. This is a very attractive theory and I believe the correct one; but it really does not serve his purpose, for it is built up on the assumption, for which he has no real evidence, that freezing does take place under the ice sheets on which he finds the marine deposits. He cannot prove that freezing takes place under the Barrier by a theory which is based on the assumption that such freezing takes place elsewhere.

It is up to me to get the discussion back on to the physical side and to show, if I can, that the problem can be solved from physics as well as from headless fishes. The physics is really very simple and has been well set out by Professor Debenham; it is only necessary to present the facts in a way more suitable to give a result than he has done. The main facts are the following: First, the mean temperature of the upper layers of an ice sheet is the same as the mean annual temperature of the air, and therefore in all the cases we are dealing with it is well below the freezing point of sea-water. Second, the mean temperature of the lower surface of a floating ice sheet is the temperature of the water on which it floats, and therefore must be between $-2°$ and $-3°$ C. according to the salinity of the water. Third, there is therefore always a temperature gradient from the lower to the upper portions of the sheet, and as ice is a conductor of heat there must always be a flow of heat from the water to the ice. Fourth, so long as the water is above its freezing point the transfer of heat from the water to the ice is accompanied by melting. Fifth, when the water is at its freezing point the transfer is accompanied by freezing. These facts are all we need to know.

Now let us return to Professor Debenham's despised equation. It is true that it includes several unknown quantities, chief amongst which are the temperature, salinity and circulation of the sea-water. When a physicist has an equation with unknown quantities there is a method of dealing with it which often gives valuable information of a qualitative nature. This is by giving extreme values

to one of the unknown terms and seeing what the consequence would be. Let us give extreme values to the circulation: first, let it be zero and, secondly, let it be very large. To make the circulation zero we will consider that a wall has been built up along the northern edge of the Barrier extending from the sea bottom to the ice. This will cut off all circulation of water under the Barrier and neither warm nor cold water can enter from outside. This, however, will not affect appreciably the temperature difference between the bottom and top of the ice sheet; so the flow of heat will be unchanged. After a brief interval during which all the water will attain its freezing point, the flow of heat will be accompanied by the formation of ice and this condition will remain so long as there is any water left under the ice sheet. Thus we reach the quite definite conclusion that with no circulation ice would be deposited on the under surface of the Barrier.

Let us go to the other extreme and consider a very large circulation of water under the Barrier. Now the temperature of sea-water may be above but can never be below its freezing point; therefore, over a long period the mean temperature of the water must be above the freezing point. When this water circulates under the Barrier it takes some time to be reduced to the freezing point, during which interval it melts some of the ice. Now as we are allowing ourselves extreme circulation we can arrange it so that no portion of water remains under the Barrier for longer than the interval in which it is melting the ice. Thus again we get a solution of our equation, namely, that there is always a value of the circulation which must result in melting.

Now let us apply this to the real Barrier. Recent exploration has given reason to believe that the Barrier occupies a great bay in the antarctic continent and that it is closed by land on all sides except on the north. Under the Barrier in such a bay there can be no large-scale current of water because there is no wind action on the surface of the water to cause circulation and there are no openings along the sides through which currents can enter at one place and leave at another. There is, however, a certain amount of small-scale circulation along the northern edge of the Barrier due to tidal action, local and temporary currents set up by passing storms and a possible general drift of the water in the Ross Sea. But these currents cannot penetrate far under the Barrier, and the circulation due to them must decrease rapidly as one proceeds south from the northern edge.

Hence the picture we form is of practically stagnant water under the south of the Barrier, where conditions approximate to those we have found for no circulation. Thus there is a very high probability, amounting almost to certainty, that there is deposition of ice on the under surface of this portion of the Barrier. On the other hand, there is some probability that there will be sufficient circulation of the water under the northern edge of the Barrier to produce some melting here, though it may be very small. Therefore we have almost a perfect proof that there must be under some part of the Barrier freezing, and there may be—not quite so certain—some melting. This is an attempt to show that we physicists are able to do something with our equations even when we cannot put in numerical values.

Before concluding, I should like to remark on the origin of the extrusion theory. Professor Debenham is correct when he says that I suggested to Captain Scott that the Barrier was expanding under its own weight; but I do not wish you to conclude from this that the idea was my own. I cannot now remember how I obtained the idea, but I am quite certain that I should not have forgotten if the idea had been my own.

Mr. A. CHERRY-GARRARD: I can only speak from actual experience. I have

no theories at all. The problem is one, apparently, of picking things up off the bottom of the sea and then conveying them, over a period of years, to the top of the ice. There is one way in which that could be done—and I believe it has not been mentioned—and that is by anchor ice. In the spring of our last year there was open water off Cape Evans which was so clear at times that it was possible to see hundreds and hundreds of bluey-white starfish on the bottom of the sea; also quite a lot of anchor ice, *i.e.* ground ice. It is well known that in rivers anchor ice will include a number of stones and other things and that finally it floats and brings up masses of material. I suggest that it is possible that some of the material seen by Professor Debenham may have risen by that means.

The way in which it is suggested that this material has been brought up is by frazil crystals. I have looked up my notes and I find that about 20 September 1912, Nelson was opening a hole in the ice in South Bay to put down a tow-net on which there was a 7-lb. sinker. It was down for four days, and when he went to pull it up he hardly had to pull at all; it floated up by itself because of the frazil crystals which had formed in four days. He thought the 7-lb. sinker had come off but he found the sinker there intact. I know that things do freeze at the bottom of the sea. Once I was trying to get skeletons of penguins. I rigged up a line and slung the penguins over the ice-foot so that the shrimps should pick their bones. When I came to pull them up they were frozen to the bottom of the sea though there was nothing but open water before the ice-foot.

You have been shown a picture of the big chasm which stopped Captain Scott on his *Discovery* expedition; he could not reach land because the chasm was too big. We crossed the same chasm or a continuation of it to get on to the Beardmore glacier. I wish Professor Debenham would tell us what he can about the big pressure waves which we met before we got to that chasm. I have sent him some hypsometer readings which we took day by day as we approached the Beardmore. Those readings show that on the night before reaching it we had a very heavy blizzard, and on the march before that night we rose, according to the readings, 400 feet. On the other hand Scott, coming out from the Beardmore 46 miles from Shambles Camp, records that he was sure he had been rising all the time; that the Barrier sinks as it reaches the coast and rises only where the glaciers press out. We met big pressure waves all the way but very few crevasses. But the second supporting party under Lieutenant Evans found the crevasses uncovered on their return. We had passed over a whole heap of them in fact, and by the time the second supporting party came by a good many of the lids had fallen in. The pressure as you get to the chasm is very great and as far as I can make out it extends for 60 miles northwards towards Cape Evans. Scott made many entries about these undulations on his return journey. There are also undulations south of One Ton Depôt, which we saw on the Search Journey.

The CHAIRMAN: Mr. Eric Webb, upon whom I now call, was a member of the Mawson expedition which went to the Antarctic in 1912.

MR. ERIC WEBB: I welcome this opportunity to pay a tribute from Sir Douglas Mawson's Australasian Antarctic expedition which was contemporaneous with the last Scott expedition, and above all to express appreciation to Professor Debenham for his erudite and stimulating as well as entertaining lecture.

Unfortunately, in our part of the Antarctic there is no true barrier ice like the Great Ross Barrier so that, quite apart from my being a mere magnetician and an engineer, I cannot offer any substantial material to assist or refute Professor Debenham's hypothesis. However, I must say that it is extremely

intriguing. To me it appears to be, from the mechanical as well as the physics aspect, a very plausible and circumstantially supported idea. We in Adélie Land always envied Scott and the others who visited McMurdo Sound because their area looked such a lovely, varied and attractive place by comparison with our hard, wind-swept piece of plateau running straight down into the sea with hardly a feature about it. We had shelf ice, including the Shackleton ice shelf which is unique in the world and projects at least 130 miles right off-shore, while the Barrier occupies the inner portion of a large bay in what is almost a round continent lying generally within the Circle. Hence, the Shackleton ice must be subject to a great deal more of the melting effect of which Sir George Simpson spoke than is the Barrier.

One might remark here on one or two points in Professor Debenham's paper. One is his recognition of the large amount of work carried out in Antarctica during the last decade and a half by the Americans. I am afraid I have been one of those who regarded their earlier expeditions in particular as being a good deal of advertisement rather than hard, tough scientific work. They did take many more typewriters and journalists with them than we have ever even dreamed of! However, I am happy to have from Professor Debenham himself this tribute to the results of the American expedition which it is unfortunate, and a little surprising, that they have not yet seen fit to publish. We hope to see them before very long.

The other aspect that has not been stressed is the importance of this particular matter to people like ourselves now living here in Europe. I believe I am right in saying that the Ross Barrier is the only sheet of ice of its kind in the world. It is of interest and of importance to us because it represents a similar sheet of ice that stood just outside the door here in the North Sea during one or more of the Ice Ages. In consequence, it is of very great importance to know whether Sir George Simpson's physical explanation applies this side of the mean or that side of the mean, and what is the significance of this natural phenomenon towards interpretation of the world around us. It is evident that the physicist by himself cannot give final proof nor explain fully the mechanism. At most, on the evidence at present available, he can say that both freezing and melting are not only possible but actually take place. It is going to rest with the more practical people, mere engineers maybe or sailors, to go and collect the direct evidence which will supply one or more of the unknowns in Sir George Simpson's equation. To that end my friends and I in the Antarctic Club are using our persuasion to stimulate interest in an investigatory expedition into McMurdo Sound. I only wish I could take an active part myself and thus see at first-hand some of the things I have imagined for so long, not least as the result of such slides as you have seen this evening. I thank Professor Debenham for his lecture, on my own account and on behalf of my fellows who have fared in those Antarctic wastes which nevertheless are so lovely.

Dr. G. E. R. Deacon (Admiralty Research Branch): I have not had an opportunity of reading the manuscript of Professor Debenham's paper and he may have considered the evidence I shall mention. Neither he nor Sir George Simpson have remarked on the increase which must take place in the salinity of the sea as ice is removed and salt left behind. The observations made by the *Discovery II* in the Ross Sea in 1936 show a significant increase in salinity from east to west along the Barrier for which there appears to be no simple explanation. The increase is greatest at the bottom; off Cape Crozier the bottom water had a salinity of 34·87 parts per thousand and a temperature of −1·94° C., while the corresponding figures for the Bay of Whales were 34·55 and −1·85° C. The intensive freezing during the winter months would be expected to produce

highly saline water such as is found in the south-west corner of the sea, but with the currents as they are—westwards along the Barrier and northwards along the coast of Victoria Land—it should be swept away in summer. It is therefore very attractive to assume that there is under the Barrier a kind of cold cellar from which water might be drawn off gradually in the south-western part of the sea. It is still more attractive to suppose that ice is formed under the Barrier and the salinity of the water increased, in summer as well as winter.

Geographers should overcome their reluctance to leave the land or ice and dip into the sea, or even into the papers in which oceanographical data are published, because the answer might be found there. The sounding along the edge of the Barrier is approximately 2000 feet, so that if the ice is 1000 feet thick, there are 100 feet of water below it. The temperature at depths greater than 1000 feet along the Barrier is less than $-1{\cdot}5°$ C. in late summer so that there can be little melting. There may be freezing, and those who support this hypothesis may find the evidence for which they are seeking in observations similar to those I have mentioned, made near the Barrier.

Mr. G. SELIGMAN: Professor Debenham's lecture has been most stimulating. The problem of the origin of the Ross Barrier—or as some prefer to call it, the Ross Shelf Ice—is capable of various theoretical solutions. Professor Debenham has mentioned three possible modes of origin: glacier ice, snow and the freezing of sea-water. We have heard some extremely interesting arguments for and against the last named of these agencies, but would it not be better to try and examine the problem empirically; that is to say, by figuratively going down on our hands and knees and having a look? There may be insuperable difficulties but I doubt it. Looked at, not with elaborate apparatus but quite simply, the crystals formed by glacier ice, the crystals formed from snow and the crystals formed by freezing sea-water are all totally different in appearance. If only it were possible to examine these crystals *in situ* in the Barrier, I think the solution of the problem would be easy. But how are we to get into the ice to see these crystals? Last summer a British party working at the Jungfraujoch was able to bore over 400 feet down into the glacier with a thermal element. That method might not be suitable for boring into the much colder shelf ice, but if the simple methods which are used in rock were introduced, boring a thousand feet would be a simple problem. I think, sir, this would be worth consideration by some future party, particularly a British party which we would all like to see in preparation.

I would like to ask Professor Debenham whether he is quite certain that the Barrier moves faster than the glaciers which come down to it on its east side? 14 feet a day is nearly a mile a year. Some of the Greenland glaciers, flowing with enormous volumes of ice, flow at a speed very much faster than that. Is it not possible that some of these subtending glaciers also flow sufficiently fast to feed, or at any rate play an important part in feeding, the Barrier?

PROFESSOR DEBENHAM: I have often thought that a paper given to such a Society as this best fulfils its purpose by provoking others to speak and that the discussion is often more valuable than the paper. I am sure that is so this evening, because two or three points have come up which I had missed or had not emphasized sufficiently. First, I should say that I expected to be blown completely out of the room by Sir George Simpson. I did my best to provoke him, but, though he did not like my headless fish, he did more or less agree with me in the end.

The point about anchor ice is one I should have noted. It does not alter the theory in any way because I only want the material, whether headless fish or marine mud, to reach the under part of this ice sheet in order to be frozen in

there and come up to the top. Anchor ice is one of the means by which it might get to the under part.

Mr. Cherry-Garrard asked me to say something about pressure waves on the Beardmore glacier. I have not been there and he has, but I would suggest that those waves are not only in the Barrier proper but in the glacier itself. As the glacier comes down the last few hundred feet it will be set into waves by the obstacle in front, so that you may get waves on both glacier and Barrier. His other point completely baffles me: that Captain Scott seemed to think that when he got down off the glacier he had to go uphill to get on to the Barrier. I have no idea how that could be so. I must leave it to the physicists to explain how you could have an ice sheet afloat which was much thinner at the sides.

I was interested to hear from Mr. Eric Webb, a member of the Mawson expedition of 1912, who has information and experience of a very different part of the Antarctic. The Shackleton Ice Barrier fills me with interest just because, as Mr. Webb said, it is out in the open sea. It may or may not have some islands holding it in; I feel sure it must have. But since it does all the things that an ice sheet should not do, it may also melt underneath instead of freezing.

Mr. Deacon's point is mentioned in the paper: that one of the ways of proving that there is freezing going on is to look for saline currents coming from underneath the ice. It is such points as these that make me feel the discussion is really more valuable than the paper itself. As to crystal structure, I think that is a promising line of inquiry, though it would be necessary to go to the Antarctic to carry it out. The last question was about the speed of glaciers, whether there were not at least some fast glaciers in the Antarctic. Very few have been measured. The Ferrar glacier moves at about 6 or 8 inches a day, whereas the main Barrier is moving at the rate of 4 feet. The Barne glacier moves only a foot or two in a year. On the other hand a floating glacier tongue is moving about 2 feet a day in the height of the summer. All those figures are well below 14 feet, the maximum for the Barrier edge.

The CHAIRMAN: I feel sure you will all agree how important it is to have Professor Debenham bring these questions before us now, with the chance of an expedition to the Ross Sea and to McMurdo Sound in the near future. As Mr. Webb indicated, there are proposals that New Zealand will send an expedition. If so, there is a clear objective in front of them: to make a further study of the Ross Barrier and, with modern instruments and experience, to try and solve the important problems which Professor Debenham has put before us.

SETTLEMENT PROSPECTS IN THE WEST INDIES

REPORT OF THE BRITISH GUIANA AND BRITISH HONDURAS Settlement Commission. (Cmd. 7533.) *London: H.M. Stationery Office,* 1948. 9½×6 *inches;* viii+359 *pages; folding maps in end pocket.* 7*s* 6*d*

THE EVOLUTION of the British West Indies politically, economically and developmentally has been punctuated by an abundance of Reports born of the labour of individuals, Committees and Commissions, Royal and otherwise. To aid perspective in viewing the work of the recent British Guiana and British Honduras Settlement Commission, it may be helpful to refer briefly to some of the reports and activities which have so notably formed the background to West Indian development in the last decade.

Following a period of increasing crisis in West Indian affairs, a Royal Commission under the chairmanship of the late Lord Moyne was appointed in August 1938. Its great report was signed in December 1939, after the declaration of war. The commission urged its early publication as a "valuable earnest of the good intentions of the citizens of the United Kingdom towards the colonial peoples in their charge . . ." and in the belief that "the fundamental problems of the West Indies will remain, and cannot be permanently affected by abnormal war conditions."

The Royal Commission was outspoken and truly went to the roots of the problem. Its recommendations, and no more, were published in 1940.[1] A speedy outcome was the appointment of the first Comptroller for Development and Welfare, Sir Frank Stockdale, who issued masterly reports [2] to cover the periods 1940–42 and 1943–44. By the end of this period real progress was being shown in schemes financed under the Colonial Development and Welfare Act of 1940. In June 1945 came, belatedly, the full 'Report of the West Indian Royal Commission,' [3] followed swiftly by a 'Statement of action taken' [4] on the recommendations of that Royal Commission. At the same time was published the report by Sir Frank (then Professor) Engledow, a member of the Royal Commission, on agriculture, fisheries, forestry and veterinary matters.[5] In 1945 too came such reports as that of the Agricultural Policy Committee of Jamaica and, under its auspices, of the appropriate committee of the British Medical Association of Jamaica on nutrition in the island. This was soon followed in 1946 by 'Nutrition in the West Indies' by B. S. Platt,[6] covering in some detail the whole field. All these reports had as an underlying theme the intractable problem set by the maladjustment of population and food supplies.

During the latter part of the decade too there have been intense constitutional writhings in some of the islands, and political evolution has taken place by a series of mutations. Further, affecting the British West Indies as a whole, there have been deliberate movements towards federation. This will surely come in due season, following the resolution passed at the Montego Bay Conference in 1947, approving in principle a British Caribbean Federation.

In parallel, as it were, to these investigations, reports and changes, has been the growth of the Caribbean Commission. First of all, in 1942, came the war-

[1] Cmd. 6174.
[2] Colonial Nos. 184 and 189.
[3] Cmd. 6607.
[4] Cmd. 6656.
[5] Cmd. 6608.
[6] Colonial No. 195.

stimulated Anglo-American Caribbean Commission "for the purpose of encouraging and strengthening social and economic co-operation between the U.S.A. and its possessions and bases in the area . . . and the United Kingdom and the British Colonies in the same area." In 1945 this successful Anglo-American body invited the Netherland and French authorities to join it to become the existing four-nation Caribbean Commission. The task is economic and social betterment with the aid of co-operative effort in mutual problems. The Commission, with international headquarters in Trinidad, has now two subsidiaries, the Caribbean Research Council and the West Indian Conference.

At the two ends of this last decade have come investigations of the possibilities of deliberate movement of peoples to and within the West Indian area. In 1939 was issued the report of the British Guiana Refugee Commission[1] which felt that "British Guiana, south of the fifth parallel of north latitude is potentially suitable for large-scale settlement by emigrants of European origin, but it has important reservations to make before formulating definite proposals." Finally, in 1948 we have the report which now comes under special review, that of the British Guiana and British Honduras Settlement Commission. This report amply reflects the changes brought by the last ten years. It was written in the light, if not in the glitter, of potential funds available through the Colonial Development Corporation.

Until there has been time for action the achievement of any Commission can be judged only by its printed report. It is first necessary to read the original terms of reference. These were:

> "1. Having regard to the recommendations made by the West Indian Conference in 1944 and 1946 regarding the need for study of the Guianas and British Honduras as an aid to the solution of the problem of overpopulation in the West Indian island territories, and further to the need to assist in solving the problem of persons displaced as a result of the World War, to investigate and report to the Secretary of State for the Colonies upon the possibilities of settlement in British Guiana and British Honduras, with the following considerations in mind:
>
> (*a*) the future needs of the population of those territories, ,
> (*b*) the need to provide outlets for the surplus populations in the British West Indies,
> (*c*) the needs of surplus populations in other West Indian islands,
> (*d*) the need to provide for the resettlement and rehabilitation of persons displaced from their homes in European countries as a result of the war.
>
> 2. In the case of British Guiana, the Commission will have regard especially to the area of the Kanuku and other mountain ranges bordering the interior savannahs and to the points indicated as requiring classification in the Summary of the Report of the British Guiana Refugee Commission, May, 1939 (Cmd. 6014)."

This was the task set to Sir Geoffrey Evans, a former principal of the Imperial College of Tropical Agriculture, who was chairman, with five commissioners and a secretary. The Commission thus had to investigate and report on the possibilities of settlement in these two comparatively empty mainland territories with the ultimate objective of finding room for surplus people from elsewhere in the West Indies and for displaced people from Europe. The Commission went to great trouble to accumulate its facts and has reported at very considerable length on the possibilities of settlement. But it has notably failed to provide

[1] Cmd. 6014.

the reader of the report with any clear account of the significance of the settlement advocated in proportion to the total West Indian need for space.

The Commission concluded (p. 189) that "settlement in British Guiana and British Honduras is possible, but only through vigorous development of their latent resources." Particular projects are dealt with in great detail and estimates of money cost are provided, usually in the form of a lower and an upper limiting figure. Tables summarize in this way possible capital expenditure in ten years. In round figures, proposed expenditure for each territory lies between £7 million and £11 million (or £14 million for British Guiana if a particular rice scheme is included). Great pains have been taken by the Commission to be thoroughly realistic in these matters. Distinction is made between those schemes which, it is believed, could properly be started at once with the knowledge already available and those schemes which, though real potentialities, require further information before development should start. More extensive soil surveys in particular are needed.

In British Guiana, it is stated (pp. 190–1), "An immediate start could be made with a large-scale forest project to extract 3,000,000 cubic feet of timber," mainly greenheart and other tropical hardwoods, "annually from the Bartica triangle and lower Essequibo, combined with a sawmill and veneer-peeling plant. It would employ about 1000 workers or, say, 4000 people." "The other project which could probably be started most quickly is the establishment of a 10,000-acre banana plantation on pegasse land on the right bank of the lower Essequibo, but certain preliminary investigations will be necessary. It would eventually employ about 4000 workers or 16,000 people." "Further projects are confidently believed to be possible, though they depend not only on the results of preliminary investigation but on comparatively costly road construction to open up the interior." The prior need of improved communications is frequently stressed. In this connection various possible forms of road construction are discussed in detail. Further, it is considered that there is "an impelling need" for a deeper port, and "the prospects for this are better on the Essequibo than on the Demerara." "Settlement in the Rupununi–Kanuku area depends entirely on the provision of access by road." "Settlement, including that of Europeans, is possible on the fringes of the Kanuku mountains. It would be based initially on pigs and poultry, with tree crops . . . later if trials were satisfactory." "A trial settlement of about 200 families would be an essential first step . . . the indications are that there should be room for at least 5000 families or 20,000 people." "European settlement would not conflict with the interests of the Amerindians and would indeed benefit the area."

It is stated that "Soils suitable for permanent agriculture exist in both the Potaro and Middle Mazaruni areas, though soil and ecological surveys are needed . . . " "cocoa and possibly coffee should do well in both areas." "The expansion of rice production is dealt with separately, since . . . it offers little scope for immigrant settlement."

In British Honduras first places are given to plans for the expansion of the sugar industry in the Northern District, the establishment of a dairying industry in the Cayo district, the establishment of cocoa plantations in the Toledo district and the upper Stann Creek area, the expansion of citrus production and the establishment of a banana plantation in the Toledo district.

As the Commissioners say (p. 190), "In both Colonies further investigations are needed, but a stage has been reached at which definite proposals can be put forward and the specific investigations needed to prove them can be defined." "The first stages will be costly whenever they are taken, and they must be taken perhaps largely as an act of faith." Throughout, the Commission takes

the very sensible attitude that it is useless to throw open new territory for settlement by immigrant individuals. For success, medically, socially, economically and otherwise, immigration, settlement and development must, certainly in this instance, go forward together on a properly planned basis under a suitable authority. Clearly there will be many difficulties but it is believed (pp. 16–17) that "a policy at once vigorous, cautious, patient and firm will achieve much, provided that the understanding cooperation of the new settlers can be secured. . . . Something of the missionary spirit will be required from all workers, as well as business acumen."

"Development would best be handled by setting up a Development Corporation in each Colony, under the aegis of the Colonial Development Corporation, in which the Colonial Government and private enterprise should be invited to cooperate" (p. 190). The projects already listed are some of those with which the Corporation would be concerned in both management and finance. In this connection it is of extreme interest to turn to the pages of H. W. Foster's and E. V. Bacon's 'Wealth for welfare,' published in 1943 though the constructive thought and planning which went into the making of this book were completed before the war. There appeared, I fancy for the first time in detailed form, plans for development of backward areas by beneficent corporations, a style of development now typified by the Colonial Development Corporation and the Overseas Food Corporation. Evolution of idea and organization has been rapid, though these two living individuals of the new species are commonly considered to be yet far from perfect. Of particular interest, relative to the present Commission's report, is the fact that Foster and Bacon used British Honduras as their prime example in demonstrating both the functions and the finances of a Development Authority. They concluded,[1] "We do not think that an investment of this order of magnitude, say, £10 million in all, is an unduly great sum for the preliminary development of a Colony with the potentialities of British Honduras." At the time those words were very boldly written. Fascinating are the comparisons and similarities between the present report and that book.

The Commission's report is full of facts, historical, geographical and otherwise, to an extent which stresses powerfully the need to make available for each Colony an informative handbook giving all essential background information. Some of the war-time 'Admiralty handbooks' would form an excellent model. In the absence of such books for British Guiana and British Honduras, the Commission's report has to carry the burden. The result is serious literary indigestion. Facts and finances, projects and provisos, abstracts and appendices are thrust upon the intending reader in a profusion and confusion which is overpowering. It is admirable, in one sense, that a commission which met in Georgetown for the first time on 16 August 1947 could sign its reports on the two Colonies on 4 May and 23 June 1948. The amount of work involved was clearly immense. But the result is a report (published in September 1948) which runs to 359 closely printed pages of mixed text, tables and appendices, set out in a form which largely nullifies the value of its content. Busy people simply will not find the time to navigate the ocean of words, to mount the waves of lengthy turbulent sentences, sometimes unintelligible at first reading, and to come at last to the Commission's conclusions. The heading "Summary of projects and estimates of cost" for British Honduras does not even appear in the contents list. The "Contents" to a report should be at once the immediate guide to the main conclusions and a simple plan of the arrangement of the

[1] *Op. cit.*, pp. 70–1.

facts. The present difficulty is accentuated by the poor typographical planning and arrangement of these most important opening pages.

The presentation of the report in fact is very bad. That is one of the two major criticisms which one cannot avoid. The other is the absence of courage enough to set the findings of the Commission, the estimated number of people who can be settled in the two colonies, in the perspective of over-population in the West Indies as a whole. Surely the terms of reference strongly suggested that this was desirable. A small attempt is made in the opening paragraphs of the Introduction but it soon peters out. Paragraph 1 contains a statement about the population of the West Indies and of the two colonies under investigation. Paragraph 2 points out that "overcrowding of population is a relative concept" dependent upon a number of factors. "There is thus no precise measure of the extent of surplus population which has to be absorbed. . . ." The task "is to suggest such prospects of development of those resources" of the mainland colonies "as will absorb people to the relief of pressure in the islands; enrich the economy of the two Colonies, and thus contribute something towards the raising of material standards of living in the West Indies generally." Paragraph 3 says that if the "plans can be accepted it should be possible over a period of some ten years for the two Colonies to absorb about 100,000 men, women and children, including about 25,000 adult workers." The Commission feels that large-scale organization of agricultural settlement is required, and that the setting up of new areas of small-holdings is unsuitable (para. 8). "We are wholly opposed to such a method, but in view of the recommendations of the Royal Commission in favour of small-holdings, we are impelled to state our view of agriculture on that footing as opposed to large estates and plantations, with particular reference of course to the problems of large scale migration." Like so much else of value in the report the meaning of the sentence is not obvious without a second reading. Further (p. 190) "there is reason to believe that the grim medical history of British Guiana is a thing of the past, and that modern methods of disease control will lead to an expansion of the present population for which it will be prudent to keep land in reserve." Interesting tables are provided relating population increase in certain areas to the incidence and control of malaria.

True enough that the extent of the surplus population elsewhere in the West Indies cannot be precisely measured, and equally imprecise must necessarily be the figure of 100,000 people who might, in the view of the Commission, acquire new homes in the two colonies within a space of some ten years. No doubt too the 100,000 would carry with them some further thousands engaged in ancillary trades. But lack of precision cannot be an excuse for not attempting clearly to relate probabilities of settlement and surplus.

In fact "the total population of the British West Indies is estimated at approximately 2,800,000 at the present time and is increasing at the rate of nearly 2 per cent. per annum. This increase means, in Jamaica for instance, an additional 20,000 persons annually in need of work or occupation," [1] and in the British West Indies as a whole an increase of 56,000 each year. "It may be observed that a population increasing at the rate of 2 per cent. per annum doubles itself in 35 years." [2] For the information of those who have not had the opportunity to read these earlier reports, it thus becomes necessary to state

[1] Sir Frank Stockdale, 'Development and welfare in the West Indies, 1943–44,' Colonial No. 189, para. 2. 1945.

[2] 'West Indies Royal Commission Report 1938–39,' Cmd. 6607, Chap. II, para. 9. 1945. Some of these figures can be deduced from Table XII on page 83 of the present Report, headed "Comparative vital statistics."

bluntly what the report of the present Commission has omitted. The proposed planned movement of population to the mainland Colonies can have no more than a negligible effect on "the need to provide outlets for the surplus populations in the British West Indies" (*ib.* of the Commission's own terms of reference).

One cannot help feeling that the present Commission's report has signally failed to seize an opportunity to forward the spirit and the wisdom embodied in the report of the West Indies Royal Commission. "An awakening of public opinion is indeed the indispensable condition of a solution of this problem" of over-population, "and every body and organization that seeks, in whatever sphere, to guide or influence opinion should recognize the responsibilities that rest upon it to assist and not to obstruct the process of public enlightenment" [1] in the matter of contraception. "We . . . regard a reduction of the birth rate as in one sense the most pressing need of the West Indian Colonies." [2]

The proposals of the present Commission are excellent. The developments envisaged must be pressed ahead, but they will scarcely help to solve the already existing population problem of the West Indies unless the fruits of the Royal Commission's wisdom are married to them.

The Report is accompanied by ten maps, one in the text and nine in a pocket. The first three are of British Guiana in black and white on a scale of 1 inch to 50 miles. The base map is that of 1915 with amendments (W.O., 1943; O.R. No. 1474). The three are listed as Colony map, Mineral map and Provisional Geological map. No contours are shown. The remainder of the maps provided are of British Honduras. Five of them are based on a black-and-white sheet of 1938 at a scale of 1 inch to about 13 miles. The topographical sheet is overprinted with contours in brown at 200 feet intervals. Overprinted in brown too are maps on the same scale to show geological divisions, distributions of mean annual rainfall, vegetation and land ownership. The map in the text is on a scale of 1 inch to 7 miles to show the soils of the northern part of Honduras, while page 31 has twelve small repeats to show mean monthly rainfalls.

G. C. L. BERTRAM

THE THRESHOLD OF ANTARCTICA

AU SEUIL DE L'ANTARCTIQUE: croisière de *Bourgainville* aux îles des manchots et des éléphants de mer. By RENÉ JEANNEL. (Publ. du Muséum national d'histoire naturelle, 5.) *Paris: Presses Universitaires de France*, 1941. 10×6½ *inches;* 236 *pages; sketch-maps and illustrations*

THE ANTARCTIC continent remained until the present century a *terra incognita* on which practically no man had ever set foot. The subantarctic islands, the threshold of the antarctic, were hardly less unknown and were in a way even more mysterious because they had a history of sporadic human settlement, though not of permanent occupation, stretching back for over a century, a history for the greater part unwritten. Much of this air of romantic mystery enshrouds them still; the modern explorer comes across lonely graves with illegible inscriptions on rotted boards, the foundations of huts, abandoned try-

[1] Cmd. 6607, Chap. 12, para. 10.
[2] *Ibid.*, para. 9.

works and wreckage obviously of great age behind the beaches, but of the men who worked and lived their rough lives here, their ships and adventures, hardly a word of precise information exists.

Late in the eighteenth century the sealers and whalers began to gather in the riches that were to be had for the taking by those with sufficient fortitude and skill to conquer the dangers to navigation and to life and limb ever present on the inhospitable shores of the stormiest seas of the world. Sealers and whalers were, with rare exceptions, unused to writing of their experiences which they no doubt regarded as all in the day's work and not at all of special interest; indeed it is doubtful if they would have received much encouragement a century ago from a public more interested in the results of the industrial revolution than in the adventures of ungenteel men in wild parts of the world. Furthermore the promoters of sealing and whaling enterprises did not encourage the disclosure to possible rivals of the exact localities of the grounds to which their captains made successful cruises.

The subantarctic is without its Scoresby, though a few sea captains have left us some account of what they saw and did, the most notable by far being the American, Edmund Fanning. His excellent observations are not to be compared with the wild yarns of his compatriot Benjamin Morrell, known in his day as the biggest liar in the Pacific. For the rest we get occasional glimpses of these lands in the writings of those whose main business was elsewhere but who made calls at one part or another of them: Weddell, Foster, Bellingshausen, Ross, and the scientists of the *Challenger*. In 1882–83 a German expedition visited South Georgia, and an English one Kerguelen, to observe the transit of Venus, and their results tell us much of the natural features and fauna and flora of these islands, but little of their human side. Later expeditions such as those of the *Valdivia*, *Gauss*, *Antarctic* and *Endeavour* add their contributions to our scientific knowledge but record little of the history which was, in any case, for the most part forgotten by their day. If only Fanning had written all he knew of these parts what fascinating reading it would be, for it is obvious from his references and remarks that he could have told us many details of value, details which he probably considered too commonplace for record. The old log-books of sealers and whalers, too few of which have been preserved, give formal particulars, short and laconic, of voyages to these lands; and returns of shipping show merely how great was the activity there, recording only the names and particulars of ships and the size of their catches.

Some of the subantarctic islands were sighted by very early voyagers. Amsterdam Island was seen by Sebastian del Cano in 1522, St. Paul Island is marked on the chart of d'Evert Gysbeths dated 1559, and it is possible that South Georgia was sighted by Amerigo Vespucci in 1502. But it was not until the time of the great exploring voyages of the second half of the eighteenth century, the voyages of de Bougainville, Cook, La Perouse, Kerguelen de Tremadec and others that the illusion of a great and temperate *terra australis* was shattered and a more realistic picture of the islands forming the antarctic threshold was gained. Most of these lands south of the Indian Ocean were claimed by France by right of discovery or occupation, and French they remain as dependencies of Madagascar, with the peculiar exception of Marion and Prince Edward Islands. These latter, previously regarded as French, about 1900 were incidentally declared by a minister of France to be of no interest to the Republic, since when they have quietly passed under British influence though their nationality was still doubtful, and no formal possession had ever been taken of them up to 1940.

In 1939 the cruiser *Bougainville* was despatched by the Government of

France on a scientific mission to the French subantarctic islands to undertake hydrographic, oceanographic and geodesic researches, and Dr. Jeannel was attached to the expedition as naturalist. This book is the outcome of his researches, and not only records his personal observations but incorporates as much as he has been able to glean of the fragmentary history of the islands and of the scientific results of other visitors. The synthesis forms a fascinating and valuable volume about one of the most interesting and inaccessible quarters of the globe. The expedition visited Marion, the Crozets, Kerguelen, St. Paul and Amsterdam islands, and the author made good use of his opportunities, for such is the stormy nature of these inhospitable regions that during the sixty-odd days of the cruise he was able to spend only sixty hours ashore. During that time, with the help of the sailors assigned to him as assistants, he made valuable botanical and zoological collections and extensive observations on natural history, geology and topography.

A brief landing was made on Marion Island and on Possession Island of the Crozets, but an attempt on Hog Island of the latter group had to be abandoned, the surf being too dangerous. Considerable time was spent at Kerguelen, the *Bougainville* making a complete circumnavigation and sending parties ashore at no less than nine different places. The author devotes five chapters to this archipelago and gives a full account of the history of its discovery and exploration, its geology, topography and natural history. Not the least interesting is his relation of the various attempts that have been made at exploiting commercially this large island, as big as Corsica. Whaling and the capture of Fur and Elephant seals are the only enterprises that have succeeded, and even they are now defunct, the shore whaling station having been abandoned in favour of pelagic whaling with floating factories, and the diminution in the numbers of Elephant seal together with the loss of the supply ship having made their pursuit profitless. An ambitious attempt at sheep farming persisted for some years but never flourished, for it was necessary to house the flocks during the winter. At Port-Couvreux there still stands a great shed that was used for this purpose; it was built with second-hand timber brought from Australia, mostly old house doors which still possess their letter-boxes and display the names of the former inhabitants of some nameless little town of the out-back.

On leaving Kerguelen a call was made at Amsterdam Island to supervise the relief of a crayfish canning company that had come to grief through mismanagement; but no landing was possible, and the author had to be content with a distant view of the slopes of this very inaccessible island dotted with wild cattle, some of the fifteen hundred descendants of a small herd abandoned by an unsuccessful settler in 1871. The last visit of the cruise was to St. Paul Island, a volcanic crater breached by the sea on one side so that a perfect natural harbour is formed. Here, as at Amsterdam Island, the sea is teeming with fish and crustacea, especially with crayfish. So numerous are the latter that as the visitor walks on the shore of the crater he sees bunches of long red antennae sticking out of the water, and it was once easy at one stroke to seize a crayfish by its feelers and throw it into the neighbouring hot springs where it was quickly cooked in the boiling water; but nowadays the temperature of the spring and of the neighbouring ground is much diminished.

In the second part of the book the author gives a detailed account of the fauna and flora of the islands and describes the natural history of the Elephant seal, the Fur and other seals, the penguins, albatrosses and other birds, supplementing his personal observations where necessary with information derived from the writings of other naturalists. His discussion of the flora and its biological associations is of great interest, as are his comparisons of some of

the latter with the rather similar conditions found at great heights on some of the mountains of tropical Africa. The description of the insect fauna and the distribution of vegetation emphasizes the great complexity of the problem of the biological affinities and the geological history of the islands and leads to a discussion of the tectonic changes which may have taken part in their formation.

In a final chapter the author goes into the question of the protection of nature in these far lands of the south. He shows the great destruction that has been wrought among the seals and other animals by the exploitation of the natural resources without thought for the future, and the great damage that has been done to both flora and fauna by the introduction of rats, rabbits and cats, insect pests, and the weeds of cultivation. He urges that official protection should be given and adds that though it is satisfactory that the Crozets have been declared a "national park," a similar declaration regarding the west coast of Kerguelen merely protects a part of the island which is in little need of protection for it is almost totally inaccessible. He points out further that such a declaration is apt to become a dead letter in the absence of any supervision in these now completely uninhabited and rarely visited islands. He quotes with approval the scheme in operation under British administration at South Georgia where the hunting of the Elephant seal is regulated so that each quarter of the island in rotation enjoys a close season every fourth year, and culling is confined to the bulls of this polygamous species. As a result of this rational exploitation the numbers of Elephant seal have greatly increased during the present century and a large annual catch is made to the advantage of an oil-starved world.

The text is illustrated with useful sketch-maps and drawings and is embellished by a number of excellent plates from photographs by the author. In addition to the original matter the book brings together a vast deal of information from many scattered sources and forms a valuable contribution to the literature of the subantarctic.

L. HARRISON MATTHEWS

EARLY MAP MAKERS OF SWITZERLAND AND THE NETHERLANDS

DIE SCHWEIZ AUF ALTEN KARTEN. By LEO WEISZ. *Zürich: Verlag der Neuen Zürcher Zeitung*, 1945. 12×8½ *inches; 232 pages; maps and illustrations.* £3

GESCHIEDENIS DER KARTOGRAFIE VAN NEDERLAND, van den Romeinschen Tijd tot het midden der 19de Eeuw. By S. J. FOCKEMA ANDRAE and B. VAN'T HOFF. *The Hague: Martinus Nijhoff*, 1947. 13×9½ *inches;* viii+127 *pages; illustrations*

'DIE SCHWEIZ AUF ALTEN KARTEN' covers in great detail the history of Swiss cartography to the close of the eighteenth century. It is much more than a listing and discussion of the relevant maps, for the author relates his subject to the general development of cartography, includes biographical sketches of the leading Swiss map makers and geographers, and examines their methods. The earliest map of the Confederation was drawn about 1496 by Konrad Dürst of Zürich, a doctor of medicine, a humanist, and an astrologer, to accompany a written 'Descriptio.' The original remained in manuscript, but was used by Waldseemüller as the basis of the separate map of Switzerland which was

ultimately published in the Strasbourg edition of Ptolemy, 1513. A later and more accurate map based on Dürst's work was made in 1520, probably by Laurent Fries. The author points out that this later map is often found bound up in copies of the 1513 Ptolemy (as in the Society's copy) and that it has therefore in the past been erroneously considered the first printed map of Switzerland.

The next outstanding name is that of Aegidius Tschudi, whose map, based upon his own observations, was published by Sebastian Münster in 1538. Münster himself encouraged his friends to prepare surveys of their home districts, using a simple method of bearing and distance. From this, elementary triangulation was developed, stimulated among the Swiss by the demands of military operations. The contribution to this aspect of Leonhard Zubler (1563–1609) is examined in considerable detail. Dr. Weisz's book, as would be expected, contains much on the development of the representation of relief. On the earliest maps there is little more than conventional outlines of mountains and of water-partings. These are succeeded by the depicting of mountains by the art of the landscape painter rather than the topographer. Finally, with the advance in triangulation, there is an attempt to express the individuality of each range in combination with the indication of their superficial extent. The work of Hans Konrad Gyger (1599–1674) is particularly notable. The volume concludes with an investigation into the mathematical basis and accuracy of these early maps by Professor Imhof. It is liberally illustrated by facsimiles, some necessarily rather severely reduced.

The development outlined in 'Geschiedenis der Kartografie van Nederland' naturally follows much the same course as in Switzerland. The authors exclude from consideration the history of coastal charts and touch only briefly on the production of general atlases, branches to which the Dutch made notable contributions. There is little evidence of map making before the sixteenth century, for "land meters," though numerous, produced cadasters rather than maps. The earlier examples are in the nature of pictorial sketches by landscape artists working from some convenient viewpoint. A more fruitful contribution was that of the engineers and surveyors engaged in building and maintaining dykes and canals, such as W. H. Croock, whose small map of the Amstelland dates from 1525. This was the period when elementary methods of triangulation were being popularized by Jamme van Dokkum (better known as Gemma Frisius). These were very suited to the flat open country of the Netherlands, where also the canals could be used as convenient base lines. It is a pupil of Gemma's, Jacob van Deventer, who ranks highest among these early cartographers for his general maps of several provinces produced about 1546. It is of interest to note that lines of equal depth were employed as early as 1584 in a rudimentary fashion to depict the configuration of river beds. This method, from which contours were developed, is generally credited to N. S. Cruquius, early eighteenth century, but it seems clear that he was systematizing a general practice. Owing to interprovincial rivalry no successful official survey of the whole country was established until the nineteenth century; until then the outstanding feature was the great series of careful and elaborate "polder" maps, necessary for the administration of the protected and reclaimed areas. The volume contains twenty-five excellent half-tone reproductions, and a summary in English which hardly does justice to the main text. G. R. CRONE

REVIEWS

EUROPE

GEOGRAPHIC TERMINOLOGICAL DICTIONARY: Czech–English. By Prof. Jiří Král. *Prague: Nákladem České Grafické Unie*, 1947. 8×6 *inches;* 133 *pages*

This work will mislead both Czech and English readers. A number of supposedly English words given in it are French or even Italian (*e.g.* beton, brunet, autostrada, pirogue, en gros, estivage, indigene, perron, etc.); others are not English in form (limitive, double-lingual, anorganic, montanic, montigenous); others, probably taken from dictionaries, are archaic or obsolete or belong to dialects (drift-way, nog, hagger); others are American (share-cropper, stoop—for stoep); others are wrong (deformity for deformation); and others are incomprehensible (fam, pump-bot). Some amusing attempts to render certain expressions would be understood by persons of nimble wit (high agedness, bamboo sugar, amphitheatre of moraine for cirque, abode of plants for habitat, rind boat for bark canoe, ice rain for hail), but others would not be (quarter hold, speed-line, kiridji-transport). Some of the renderings are wrong: a lagoon-island is not an atoll but an island in a lagoon; guano does not mean manure in English; a pile of wood is not the same thing as a wooden pile; and a dome-shaped mountain may be a *ballon* in French but is certainly not a balloon in English. Even from the Czech point of view the work seems to be unsatisfactory. On the Czech Staff map on the scale of 1:75,000, pine groves and pine copses are shown as *bor* and *borek* respectively, but from *bor* Dr. Král merely gives a cross-reference to *les borový* (pine forest), and he does not list *borek*. Many of the simple but important geographical terms which appear on the Staff map have found no place in Dr. Král's dictionary. But if expressions like *domek weekendový* (for week-end cottage) are really acceptable in Czech, the possibilities for corrupting the language through loan-words are grotesque. Inter-linguistic lexicography should be undertaken only by persons with a close, idiomatic knowledge of the languages concerned. Dr. Král's attitude towards the work is pedantic and he does not appreciate what constitutes living English or what distinguishes American from English usage. His work is nevertheless of a most important kind, for the sake both of national research and of international understanding. To attempt it on the scale on which he has undertaken it—for he promises Czech–French and Czech–Russian dictionaries—is very courageous. But to expect foreign specialists to carry out the necessarily heavy revision for which he asks is to expect more than can be given. M. A.

HÖJDEKORT OVER DANMARK. *Scale* 1:250,000. 4 *sheets*, 34×31 *inches*.
LANDSKABSKORT OVER DANMARK. 1:250,000. 4 *sheets*, 34×31 *inches*.
ODSHERRED, ET DANSK MORAENELANDSKAB OG DETS TILblivelse.. 1:65,000. 1 *sheet*, 24×22 *inches*.

Copenhagen: Geodaetisk Institut, 1947.

The four sheets of the relief map can be used together as a wall map. Relief is shown by means of layer colouring in green and brown, with contours at 10, 40, 80, 120 and 150 metres and depths of coastal waters at 6, 10 and 30 metres. The variation in contour interval is unexplained but is employed,

presumably, on account of the large area of low elevation and the small area above 150 metres. The areas exposed at low water are also mapped. Towns are printed in red to indicate their extent and shape, population being indicated by the size and style of printing. Smaller towns and villages are differentiated into four types according to size and function. Manor houses (*Herregaarde*) are also marked. Other information includes railways, main roads, churches, quarries, power stations, airports, lightships and ruins. The main areas of deciduous forest, coniferous forest, heather moor, meadow and marsh are overprinted in symbols.

Inset maps include Copenhagen on a scale of 1 : 100,000 indicating stages of growth of the city; county boundaries (*Amter*) and ecclesiastical divisions (*Stifter*); Greenland on a scale of 1 : 4,500,000 with ice covered and ice free areas and spot heights in metres (settlements, trading posts, fishing ports and mines are differentiated); the Faroes on a scale of 1 : 250,000 with layer colouring at contour intervals of 200 metres and settlements according to size.

The base for the morphological map is the same as the relief map without contours and layer colouring. The morphological subdivisions number twenty, and are inserted by means of a broad range of colours and symbols. They represent a detailed and valuable contribution to the mapping of the glacial and post-glacial morphology of the Danish landscape. The older glacial moraine and drift material is mapped distinctively from the deposits of the last glaciation. Eskers, tunnel valleys and dead ice features are shown, and in Bornholm the area of crystalline rocks with erratics and roches moutonnées is indicated. Areas exposed by retreat of the Yoldia and Littorina Seas and their coastlines are marked. Other features included are sand dunes, cliffs, marshes and reclaimed areas. An inset map (scale 1 : 65,000) shows the ice front positions during the last retreat. Another gives the simplified morphology in the Faroes.

The Odsherrad area of north-west Sjaelland is shown on the third map, together with three block diagrams illustrating stages of evolution. The close relationship of the present landscape to the advance and retreat of the last glaciation will be immediately obvious from an inspection of this excellent map, with a key in English. R. T. C.

ASIA

GEOLOGY AND GEOGRAPHY OF KARACHI AND ITS NEIGHBOURHOOD. By MANECK B. PITHAWALLA and P. MARTIN-KAYE. *Karachi*, 1946. 10×6 *inches;* xi+82+viii+158 *pages; maps, diagrams, and illustrations. Rs.* 20

This volume represents a happy example of Indo-British cultural cooperation: Mr. Martin-Kaye, a London finalist in geology, spent his leisure from R.A.F. duties on field-work, while Professor Pithawalla is well known as a writer on Sind. Part 1 is a detailed memoir on the local geology. The only criticism the reviewer can make is that more attention might have been given to geomorphology and in particular to coastal problems; it is not made clear, for instance, whether Clifton, Karachi's seaside promenade, is in fact a raised beach area which it certainly resembles on cursory inspection.

In Part 2 a wide range of topics is treated—perhaps too wide; one cannot see the relevance, for example, of the questionnaire and potted advice on animal diseases. Clear accounts of population growth and of the development of the port are given. The latter would be improved by reference to the effects of the American Civil War and of the establishment of through rail connection to the Punjab in 1878; in fact there is a great gap in the treatment, from before

British times to 1912–13. Karachi, a city approaching half a million inhabitants in an intensely arid area, has one of the most difficult and complex problems of urban water-supply in the sub-continent, and the detailed analysis of this is one of the most interesting sections in the book.

Karachi is now the capital of the largest Muslim state, by population, in the world; and the new possibilities are large. But it can hardly be denied that the city has a long way to go before it really measures up to these new responsibilities. Industrially it is as yet almost negligible: Professor Pithawalla can only muster some 40 local industries, and some of these, such as the Kailash Perambulator Works which makes wooden toys, are hardly big business. Culturally too it is far behind Lahore. The recent proposal to shift the capital of Sind to Hyderabad and to erect Karachi into a Federal District has provoked heated feelings among Sindhi legislators. Such topics would repay more detailed study in a second edition.

Despite some not unimportant omissions, the book is the most comprehensive geographical study of any city of the Indian sub-continent that has yet appeared, and for this our thanks are due to Professor Pithawalla and to his collaborator. The production is better than is usual in India or Pakistan and serious misprints are few. O. H. K. S.

THE BRITISH IN ASIA. By GUY WINT. *London: Faber and Faber*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 224 pages. 12s 6d*

With the end of British rule in India, a large body of writing, some of it good, has lost actuality and become history. It is one of the merits of Mr. Wint's book that although it was written in 1946, it looks forward as well as backward with remarkably steady judgment and remains "actual" in 1948. Primarily it deals with the changing problem of Indo-British relations and is in effect a plea for continued close association of India and Pakistan with Britain in the interests of peace in southern Asia. But this might easily have been a piece of *ad hoc* political argument, valid enough within its limits but still limited. Actually Mr. Wint takes a wider range both geographically and philosophically, and it is this union of wide vision and penetrating insight which lifts 'The British in Asia' far above the generality of its class.

Part 1 (half the book) describes the pattern and some of the problems of British rule in southern Asia. Mr. Wint sees it, perhaps with some exaggeration, as in reality a joint Indo-British dominion. It is rather difficult to square this emphasis with his acute diagnosis of the fundamental (though probably inevitable) failure to effect a true synthesis, and of the malaise and frustration of Indo-British society; and he might have considered how insidiously and yet powerfully this frustration sapped British energies as well as Indian. This section includes brief but excellent surveys of Burma, Ceylon and Malaya, and is succeeded by 25 pages (Part 2) on the Tsarist and Soviet achievements in Asia—impressionistic of course but exceedingly stimulating. His conclusion might be expressed by saying that the British made half a revolution and the Soviets a whole one. The implications are profound, and if they are not followed out (which after all is not the purpose of the book) at least the seeds of reflection are sown. The conclusion (Part 3) deals with possible trends of polity in southern Asia. As well as a review of the likely interests and attitudes of the "succession states," it has a chapter on the great powers notable for its brilliant presentation of some underlying factors in American ideology.

This outline gives no idea of the many excellences of the book, not the least of which is a vivid and supple style, moving easily from factual description and illuminating anecdote to high philosophical argument. Of course there is

material for disagreement: for example, in dealing with Burma Mr. Wint misses the enormously important fact, very relevant to his argument, that owing largely to the historic accident that until 1937 Burma was administered as an Indian province, there was virtually no independent Burmese middle class; and he does not sufficiently examine, though he is not unaware of, the Indian sub-imperialism which in the Indian Ocean lands filled (and in some still fills) the interstices of British imperialism. There are also weaknesses in his presentation of the case for continued British association, which in places looks too like a plan for a British Senegal as a reserve of man-power to have any appeal for Asian leaders. This is perhaps realized in the rather lame conclusion (p. 207) that it is improbable that India's interests "would impel it towards any bloc of which Great Britain was not also a member." On the whole one must agree with Mr. Wint's own assessment: "This is a gloomy book, but it is hard to see where its thesis is wrong." And for the reviewer at least its detail also is extraordinarily convincing. It is a book of the first interest and even importance. If one short work had to be recommended to a student with some general knowledge of Asia, to inform him of the problems of what may be the Asiatic renaissance, this is it. O. H. K. S.

THE JUNKS AND SAMPANS OF THE YANGTZE. Vol. 1. Introduction; Craft of the estuary and Shanghai area. Vol. 2. The craft of the lower and middle Yangtze and tributaries. By G. R. G. WORCESTER. (China Maritime Customs, miscellaneous series, 53, 54.) *Shanghai: Inspectorate General of Customs*, 1947, 1948. *London: Kegan Paul, Trench, Trubner.* 11×9 *inches;* xxviii+245 and 260 *pages; maps, diagrams and illustrations.* £2 each vol.

Mr. Worcester has already published two studies of Yangtze craft, 'Junks and sampans of the Upper Yangtze' and 'Notes on the crooked bow and crooked stern junks of Szechwan.' The first of the present volumes deals with the craft of the estuary and Shanghai area and its companion describes river craft between the estuary and Ichang, so that we now have a complete description of the boats and vessels of the whole Yangtze system. Chinese vessels and their gear form a subject of their own and can only be treated by someone with personal knowledge and full opportunities for observation. Mr. Worcester has these qualifications and adds to them a capacity for accurate and careful description and an equally important ability to draw. His books are therefore of the greatest value. R. C. A.

NORTH AMERICA

HISTORICAL GEOGRAPHY OF THE UNITED STATES. By RALPH H. BROWN. *New York: Harcourt, Brace,* 1948. 9½×6½ *inches;* viii+596 *pages; maps and illustrations.* $7.50

Professor Brown's mature and scholarly book is an outstanding contribution to the study of historical geography. Its twenty-nine chapters of clear legible type contain a wealth of detail quite unequalled in any other single volume on the history of settlement in the United States. The contents are divided into six parts: the colonization period; the Atlantic seaboard at the opening of the nineteenth century; the Ohio River and lower Great Lakes region to 1830; the new North-West, 1820–1870; the Great Plains and bordering regions to 1870; and from the Rocky Mountains to the Pacific coast, also to 1870. An extensive bibliography, a biographical index and a complete subject index conclude the volume. The book deals mainly with settlement and the geographical factors affecting it, political events receiving very little emphasis. The general west-

ward trend of American settlement has allowed the author to combine historical and regional aspects in a most successful way; yet the loss of a unified picture, somewhat inherent in regional treatment, is overcome by judicious retrospects and the frequent insertion of maps of the whole of the national territory. The reader is always kept well aware of space and time by the use of "original eyewitness accounts" and the reproduction of contemporary maps and diagrams.

"The character of the regions in earlier times" is described with intimacy and brilliance. The illustrated description of Sable Island—which is ignored even in the *Canada Year Book*; the magnanimous credit given to the beneficial influence of Indian civilization on the early colonization of the eastern seaboard; the mention, in the Great Plains section, of those super-men, the hand-cart migrants, and the account (with a map) of the locust *Melanoplus Spretus*, serve to illustrate the completeness of the matter. Yet throughout his patient synthesis Professor Brown never deviates from the geographical path. The text, although so detailed, is remarkably free from discrepancies, but the mention (in a quotation, p. 51) of an Irish Free State in 1790, the printing of 14,000,000 for 1,400,000 tons (p. 120), and the inclusion of woollen kerseymeres among cotton fabrics (p. 153) need amending. The book has at once become and will long remain the standard one-volume reference to the historical geography of the United States. R. P. B.

THE MISSOURI VALLEY; land of drought, flood and promise. By RUFUS TERRAL. *New Haven, Conn.: Yale University Press (London: Oxford University Press)*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* x+274 *pages.* 21*s*

The author of this interesting book is a St. Louis journalist who is obviously passionately devoted to securing for the Missouri Valley an authority on the lines of the T.V.A. which has done so much for the smaller Tennessee Valley. His book is written in free style, and while "popular" in character is nevertheless based on a wide knowledge of the problems involved and of the factors which have operated in the area up to the present. The river basin is surveyed in all its aspects—water, mud, silt, sediment, drought, soil erosion, irrigation, navigation, utilization by man, the effect of unregulated private enterprise, the jealousies of conflicting interests—and a very vivid picture of "Old Misery" is the result. The importance of the ninety-eighth meridian is dealt with and the conflict of interests between those living east and those living west of it. The merits and demerits of two proposals later merged into one (the Pitt-Sloan Plan) are also investigated.

The book is propaganda, but it is balanced in outlook and judgment and makes a strong case for a new and a whole view of the needs of the valley, its farming and industry, and the people who must live by them and with one another. It is a book which those interested in the re-juvenation of this rather neglected part of the United States will read with profit. The only illustration, unfortunately, is a map of the Pitt-Sloan Plan, but there is a very useful bibliography which includes technical and government publications. L. B.

SOUTH AMERICA

UTTERMOST PART OF THE EARTH. By E. LUCAS BRIDGES. *London: Hodder and Stoughton*, 1948. $10 \times 6\frac{1}{2}$ *inches;* xxi+558 *pages; maps and illustrations.* 30*s*

This is a wonderful book. It is three histories in one: the history of Tierra del Fuego or Fireland; the brief history of the uplifting of the Yahgan savages by Thomas Bridges, and of the Ona by his son Lucas (the author), to a happy state

of self-respect and self-reliance in which they continued till murder, civilization and measles reduced them to a few remnants; and throughout one follows the history of this man and his children and descendants over a period of nearly ninety years. It starts with a romance: the young missionary—not yet ordained—arriving with his wife on that desperate and desolate coast, after an appalling sea voyage, to make their home and life-work there. He was weak physically, and small in stature. He was sick, and died comparatively early. But he had already made men of the Yahgan "canoe Indians," and it was left to Lucas Bridges to make men of the Ona, the virile and warlike Guanaco hunters. Thomas Bridges knew Fuegia Basket, one of the Indian children taken to England by Captain Fitzroy and familiar to every reader of Darwin's 'Voyage of the *Beagle*.' His son brings us up to 1947 in the history of the country.

Perhaps the best part of the book is the main bulk of the middle, in which the author as a strong, tireless young man hacks a great homestead for himself out of an appalling snow jungle, helped by Indians to whom he refers as to people of his own family and most of whom had slayings and murders on their hands. All is told with the impersonal modesty of an elderly man writing of the time when he was young and strong, matching his own body against those of the splendid Ona, apparently remaining their leader in a system of brotherly equality. His greatest feat perhaps, of which he writes with characteristic modesty, is how he induced the Mountain tribe and the Northern tribe to discontinue a blood feud which was decimating them at a time when they could ill afford loss of life. To give a few examples of Mr. Bridge's way of writing: he describes his marriage in 1917 (he was then 43), "when disguised in King's uniform I acquired a wife." He knows that two desperate killers among the Ona are out for his life; he says "I sought them out and upset their plan." He describes Tierra del Fuego's original inhabitants in 1947: "On Cape Horn Rock, and the small islands of the Wollaston group and the western islands of the archipelago, a few otter hunters still roam about just managing to keep themselves alive."

The author is no geographer, naturalist or missionary; and while his father started as a missionary he later became a pioneer *estanciero*. Yet most of the incidents he describes were set where no white man had ever trodden before; and his observations of birds and beasts are of intense interest to a naturalist. He was a pioneer, probably harder and tougher than any of the hardy, tough pioneers of that country, but one who never forgot the Christian principles in which he was raised and who "tempered justice with mercy" when he could, "tempered violence with justice" when violence was unavoidable, but laughed a difficult matter away by sheer tact and good humour ninety-nine times out of every hundred. Yet he is so cleverly impersonal that it was only on the last page that I said to myself, suddenly remembering, "I feel proud that it is an Englishman who has lived and written this." M. H. M.

AUSTRALIA

THE MURRAY VALLEY: a giant plan for its development. By J. MACDONALD HOLMES. *Sydney: Angus and Robertson*, 1948. 10×6¼ *inches;* xv +280 *pages; maps and illustrations.* 30*s*

The geographical study of an area of 100,000 square miles, spread along a river some 2000 miles in length, is no mean task for a man who is also occupied with other duties. The author styles the book a reconnaissance which is perhaps an understatement; nevertheless readers must forgive certain inadequacies in the book because of the magnitude of the area.

The first section is called the "Legacy of the past" and is aptly named. It shows how the accidents of exploration and settlement determined a threefold division of the valley which is essentially a unit and have therefore hindered its development as a whole. To English readers the details of land tenure in the early years of development will be rather uninteresting, but something of the kind was necessary to show that the early experiments in settlement and land-use are an integral part of the problem to-day. For the most part it is a story of gallant failures to make something of an area which is largely marginal land, without sufficient knowledge of the physical environment and with slender capital resources. The competition of the three states having rights in the valley is described, a rivalry which led to something like a "race for the river" which was almost always won by Victoria.

In the second section the author returns with gusto to his thesis of "regional responsibility," a subject which he previously outlined in his book on 'The geographical basis of government.' In spite of certain obscurities of diction and what some may regard as an overworking of the terms "region" and "regionalism," this section is thoughtful and valuable. It reminds central authority, all too apt to plan expansively on paper, that local consciousness is the moving spirit which must finally carry out schemes of development. There is a wholesome challenge in this sentence: "a fully planned economy is false and dangerous when it ignores man's fundamental allegiance to that which is small, intimate and thoroughly understandable." The author is very much at home when he is planning new boundaries, whether of small municipalities or of huge states, and for the Murray Valley he decides on a division into six regions for reasons which are stated fully in later chapters and which seem valid enough.

The physical geography of the valley follows in Part 3, but it is purposely abbreviated to "the salient aspects which, aided by the maps, bring out general patterns." This brevity was inevitable perhaps, but it is regrettable since it is inadequate to enable the English reader to appreciate the political and economic arguments which follow. The Australian reader for whom the book is written, having access to a large number of technical papers on this aspect, may not be worried thereby. In this section there are some astonishing facts about the regime of the river which will interest those concerned with water resources. For instance, the discharge from year to year at Albury, which is 1300 miles from the mouth, varies between one million and ten million acre-feet. To regulate the flow of such a variable river so as to secure the best results is clearly a tremendous task. Another significant figure is the estimated loss in one of the irrigation schemes from evaporation, seepage and other causes, which appears to be about 60 per cent. of the water delivered from the weir. No wonder the author states that "there is much to be said for the view that savings in distribution are more valuable than increases in storage." A statement which will cause some surprise to engineers is that a 50 per cent. run-off "would be a true enough general figure for forest and grassland areas in Australia." It would seem that the term "run-off" is here used in an unusual sense since for similar latitudes in Africa the run-off, in strict usage, would rarely be above 12 per cent. The proportion of seepage from the river into the flat lands on either side may be considerable and there may well be a future for a system of pumping from tube-wells driven at a distance from the river, such as that instituted with such success by Sir William Stampe in the Central Provinces of India. The author concludes that more water must be conserved in the future and he appears to favour a multiplicity of small headwater dams rather than excessively large ones lower down the river, an opinion which the reviewer would heartily endorse on general grounds. The need of the valley for cheap power is just as

great as it is for water, and ultimately a full use of the high-level water for power plants must be made.

The fourth and final section of the book deals with "Basic problems and regional control," in which the author expands his theorem that "the social organization of an irrigable area is as much a problem as its actual water supply." This he does with considerable effect though the treatment is somewhat discursive. He has suggestions to make on most of the problems, including the best use of the curious "mallee" areas, the ideal irrigation town and the control of land values.

His last chapter on "The next step in governmental re-orientation" is bold and constructive in spite of its somewhat obscure heading. Whether people will agree with his suggestions is perhaps of less importance than the fact that the author shows himself to be one of the few people who can look at the problem of development as a whole, in the proper geographical way.

There is a certain lack of balance in the book which is due presumably to lack of time in which to prepare it. Thus there are occasional lists of data extracted from reports which introduce detail where broad summaries would have been more useful. The reader is sometimes led up most promising byways, such as a description of the dried-fruit industry, which turn out to be blind in the sense that the details of the industry and the mode of life of the participants are omitted. Nevertheless these are minor defects by comparison with the many excellences in a book which should be both a spur and a guide to the planners of the future of the Murray Valley. F. D.

ANTARCTICA

SOUTH WITH MAWSON. By CHARLES F. LASERON. *London and Sydney: Harrap*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 223 pages; map and illustrations. 12s 6d*

The official story of the Australian Antarctic Expedition, 1911–14, has long since been told by its leader and has passed into history. This book does not attempt or claim to retell it but is a well-told yarn of personal reminiscences by the assistant biologist of the expedition. "This was very nearly the last of what might be termed the 'old style' of expeditions, before the great advance of mechanical equipment revolutionized the methods used. . . . Now the uncharted stretches of coast line have become less and less. Aeroplanes in the air, tractors on the ice eat up distances once traversed slowly and painfully on foot." The details of day-to-day life and the revealing personal touches give a picture of a band of splendid men, mostly young Australians, making light of their struggle against the blizzards of one of the most terrible parts of the Antarctic known. The book ends with the tragic story of the loss of Ninnis and Mertz, and of Mawson's almost incredible journey alone back to the base. This is the only chapter dealing entirely with matters that were not personal experiences, and is all the more moving for being told simply. L. H. M.

PHYSICAL GEOGRAPHY

THE FORMATION OF CONTINENTS BY CONVECTION. By G. F. S. HILLS. *London: Edward Arnold*, 1947. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches*; 102 *pages; diagrams. 7s 6d*

Mr. Hills is a retired Civil Servant who has now happily found the leisure to indulge in his hobby of geophysics. The result is a controversial and stimulating little book on the origin of continents and a great many related problems. Two theories are fundamental to his argument. The first was suggested by Hills

himself in 1934, when in the *Geological Magazine* (vol. 71, p. 275) he outlined a system of convection currents in the rocky shell which, operating during solidification, might separate off the continents like a surface scum.

The second theory is due to H. Jeffreys, who showed that major vertical movements of the crust were possible by differential cooling beneath the continents and oceans. Hills has developed this idea to produce horizontal movements as well, by the hydrostatic outflow of a plastic substratum from beneath a raised continent. The substratum can only escape after the continental edges have been weakened by sedimentation. Using these hypotheses, Hills explains the formation of fold mountain ranges and their roots; of the Atlantic rift by the frictional drag of a plastic substratum as it is moved outward from beneath Laurasia and Gondwanaland; of fjords by the shattering of the coast due to differential movement between the ocean floors and coasts, and of island arcs. The outflow of a great mass of basaltic material beneath Gondwanaland poured over the Pacific floor, slowly pressing down the floor and giving rise to volcanoes as the top surface solidified. On these slowly sinking volcanoes originated the coral islands. The Quaternary Ice Age is explained by a land bridge connecting North America with Eurasia over the Pole. Like the other continental masses, radioactive heating under this bridge caused doming with subsequent development of ice and anticyclonic conditions. Continued movement of the substratum caused the Arctic (and Atlantic) rifts, and subsequent disappearance of the ice sheet. A similar mechanism is suggested for the Permo-Carboniferous glaciation of Gondwanaland. Finally these ideas are used to account for the observed weight of salt in the sea, and for the absence of calcareous fossils before the Cambrian.

Perhaps the most remarkable thing about this book is the almost complete disregard of contraction to account for compressional horizontal movements. It would have added to the value of the work if Hills had given his reasons for this neglect, since as far as one knows, contraction is able to provide sufficient forces for all the main orogenic periods, and furthermore is able to account for the quiescent periods between them. Hills does not attempt to find the order of magnitude of the period of his mechanism. It is this theory of horizontal movement which is the most controversial part of the book. Hills' own theory of convection currents to account for the distribution of continents is probably the best before us to-day, while Jeffreys' asymmetrical cooling theory provides for vertical movements of about 10 km. which is sufficient for most purposes, including the foundering of continents.

In the course of his discussion on fjords, Hills suggests that submarine canyons may be drowned fjords. This seems to be a more likely mode of origin than sub-aerial erosion, necessitating a continental depression of several thousands of feet, or density currents, the efficacy of which are still in doubt.

The book is well produced and seems free from misprints except for two faulty references on pp. 29 and 35. Mr. Hills is to be congratulated on his synthesis in a field providing some of the most challenging features on the surface of the earth, which still defy human skill and ingenuity in their full elucidation. H. I. S. T.

GLACIAL GEOLOGY AND THE PLEISTOCENE EPOCH. By RICHARD FOSTER FLINT. *New York: John Wiley and Sons (London: Chapman and Hall)*, 1947. 9×6 *inches; xvii+589 pages; maps, diagrams and illustrations.* 36*s*

The earth's vast geological "past" reveals the slow evolution of the continental masses and their floras and faunas towards something approaching their present

form. Between it and the short historical "present" lies that most fascinating of all epochs of earth history, the Pleistocene. This time relation alone gives the period a unique position in the realm of knowledge, for in it lie the clues to the form of the lands to-day and the distribution of life on them. It has however other claims to special attention for within its, geologically speaking, brief span of less than a million years there occurred the repeated development of ice-sheets of spectacular dimensions in the northern hemisphere. These world-wide climatic oscillations led to large-scale migrations of flora and fauna as well as major changes in sea-level.

So near to our own time were these events that the present distribution of plants and animals and the evolution and environmental adaptation of man himself may be considered as built upon a foundation of fluctuating rather than static climatic control. Knowledge of that changing physical environment is therefore essential to a very wide range of studies—botany, zoology, climatology, geography, history, archaeology, ethnology and so on.

Many factors such as water-supply from glaciers, and soils, show an appreciable lag in adjustment to changing climate, as indeed do the nature and distribution of man's activities within historic times. On the purely physical side this lag in adjustment finds its most striking expression in the changes in sea-level due to the decay of the last great ice-sheets of Europe and North America. Relief from the crustal depression due to ice-load is still in progress in the Baltic and in the Hudson Bay and Great Lakes region of North America. Predictable changes in sea and lake levels within the next millennium present an admirable field for long-term planning of coastal belts and water-borne trade routes that are largely free from the vicissitudes of economic trends.

Professor Flint, a life-long student of the problems of glacial geology, is well qualified to produce this comprehensive account of the twin subjects of Glacial Geology and the Pleistocene Epoch—truly twins, but of a parentage not fully established. The author favours what he appropriately terms the Solar-Topographic Hypothesis, a chance association of variation in solar radiation with continental elevation. He is critical of the claim of the Astronomical Theory to be one parent, even in its modern form as developed by Milankovitch and others. One realizes with real regret that Professor Flint's discussion of this theory was written before Professor Zeuner's able exposition of it in his 'Pleistocene period,' with its full supporting geological data from Europe, was available to him.

The first third of the book deals with the basic concepts of the accumulation and movement of glaciers and ice-sheets, with their erosional and depositional activity and with periglacial processes. This is perhaps the finest part. It will be of great value to glaciologist, geomorphologist and geologist and would indeed justify at least a younger sister 'Glaciology' as an addition to the aforementioned twin title. The trend of modern views on such subjects as the character of ice movement and on the stagnation-decay concept receive balanced critical treatment. The author is himself a pioneer in the stagnation theory and the reviewer recollects illuminating discussions with him amid the eskers and kames of the Carlisle area nearly twenty years ago.

Laborious compilative features, such as the contour map of levels of cirque floors for North America and the summary of recent studies of the glaciated areas of Central and North-east Asia, deserve special mention.

The middle third of the book covers Pleistocene stratigraphy and deals firstly with North America. The close analogy between the three-fold character of the latest Wisconsin glaciation there and the similarly composite Würm and Weichel glaciations of Central and Northern Europe respectively, reinforces

previous trans-Atlantic correlations of these major divisions of the Glacial Epoch. One searches in vain however for a bipartite character in the individual descriptions of the earlier North American glaciation to compare with that which is widely accepted for each of the pre-Würm glaciations of Europe. It is this latter feature which forms so striking a parallel with Milankovitch's theoretical curves. Flint, in a later section, rightly emphasizes this lack of agreement between the North American evidence and the Astronomical Theory. European studies have been more intensive than much of the American work and it would be unwise perhaps to dismiss the possibility that the number of horizons of deep weathering (gumbotils), that there constitute a prime factor in the separation of superposed boulder clays of distinct glaciations, may not eventually be found to be more numerous than is at present recognized.

This portion of the book contains by far the best comprehensive account of Pleistocene stratigraphy that has so far appeared since James Geikie's 'Great Ice Age.' The available material is enormous but the great difficulties of selection and condensation have been effectively met. Consequential effects in the extra glacial regions, for example arid and subarid areas, are well described.

In the third natural division of the text the author gives critical accounts of a number of important subjects. It includes careful summaries of the facts and balanced discussions of the changes in level of land and sea, of glacial, interglacial and post-glacial climates, and of hypotheses of fundamental causes of climatic fluctuation. There are also useful summaries of major items in the fossil record of the Pleistocene and a valuable list of references.

The great range of the subject matter and the many facets of individual items make selection and treatment of material a major problem. No one book could meet the criticism that some aspect or another was cursorily discussed, though Professor Flint's volume goes a long way towards doing so. It does not therefore displace Wright's 'Quaternary Ice Age,' Cotton's 'Climatic accidents,' or Zeuner's 'Pleistocene period.' Nevertheless, as a comprehensive integrated study of the basic facts and theories it fills many substantial gaps and will be widely appreciated as the best-proportioned general treatment available. The illustrations are well selected and the correlation tables deserve special mention. The author is to be congratulated on a work which can be strongly recommended to all whose work or interest lies within, or in contact with, the manifold problems of the earth's immediate past. S. E. H.

MATHEMATICAL GEOGRAPHY

THE QUADRANT AND THE QUILL: a book written in honour of Captain Samuel Sturmy. By CYRIL ERNEST KENNEY (limited ed.). *London*, 1947. 13 × 10 *inches;* 166 *pages; illustrations.* £3 3*s*

Mr. Cyril Kenney, himself a quantity surveyor in active practice, began many years ago to collect early printed books related to surveying in all its aspects, and to such kindred topics as fortification, gunnery and navigation which sprang from the sixteenth-century application of geometry to practical problems. He now has a very fine collection, including some rarities which cannot be found either in the Bodleian or at the British Museum, and these he has laid under contribution in the present book, which he describes as written in honour of Captain Samuel Sturmy, author of the *Mariner's Magazine*, 1669. The text consists largely of quotations from Sturmy himself and from his contemporaries, and it is illustrated by nearly a hundred beautifully produced plates, comprising maps and plans, diagrams from the *Magazine*, and facsimiles of the title-pages

of the books known or conjectured to have been in Sturmy's library, together with reproductions of portraits of their authors.

Sturmy himself is an interesting character, one of a close-knit professional group, ignored by historians, who yet played an important part in promoting the advances in technics which characterize the seventeenth century. While mathematics was completely neglected at the grammar schools, and tolerated at the universities only in so far as it was "pure," the forceful Preface on its practical importance which John Dee wrote for the first English edition of Euclid struck the imagination of many young men outside academic circles. Self-taught themselves, they set up as mathematical teachers and writers, finding their clients among young clerks and accountants, young sailors and soldiers, who wanted to make their way in the world. For wealthy patrons they constructed sun-dials of every imaginable freakish shape and pattern, adorned with an extraordinary lavishness of ornament, for these dials were fashionable in an age which was already beginning to pride itself upon its gardens.

Such was Sturmy who, as a very young man, had risen to the command of merchant ships sailing to the West and East Indies but had early (perhaps through ill-health) retired from the sea, and then lost his shore job with the Customers of Bristol. He seems to have relied on the *Mariner's Magazine* to restore his fortunes, for although particularly stressing navigation it was a compendium of all the mathematical arts as understood at the time, and when it was finished he had a copy chained to a desk in the parish church of Easton or St. George's, where he had his home. But within three months he was dead, at the age of thirty-six. He had undertaken to explore Pen-Park Hole, just across the Avon, and went down nearly 200 feet with ropes and ladders accompanied by a lead miner. Whether because of the evil spirit which affrighted the miner in an inner cave, or merely because he caught a chill, his subsequent illness was fatal. Yet he found strength to write down his observations, and these were years later communicated to the Royal Society. The Fellows knew him already, for he had sent them observations of the magnetic variations and of the tides, and the latter were subsequently used by no less a person than Isaac Newton.

Among his personal friends and acquaintances Sturmy counted William Leybourne who surveyed the London streets after the Great Fire, Henry Phillippes the seamen's teacher who watched the tides from his house on London Bridge, John Gadbury the almanack maker and astrologer, old Staynred the Bristol gauger, Walter Hayes the famous instrument-maker at the Cross-Daggers in Moorfields, and a host of others. They were not gentlemen, a present-day school-boy of sixteen could beat them at mathematics, their pretentious literary style often makes us smile, but they filled to the best of their ability the lamentable gap in the English educational system of their day, and in honouring Captain Samuel Sturmy by this fascinating scrap-book, Mr. Kenney pays tribute to them all. E. G. R. T.

SOCIAL AND ECONOMIC GEOGRAPHY

REVOLUTION OF ENVIRONMENT. By E. A. GUTKIND. *London: Kegan Paul*, 1946. 9×6 *inches;* x+454 *pages; maps, diagrams and illustrations*. 30s

Gutkind was best known amongst us for his studies of population problems, but here we have his *cri-de-coeur:* "Man is not merely a pawn in the game of *laissez-faire*." And here he abundantly criticizes the planners who think in terms of streets and vistas instead of in terms of people in community. Centrifugal forces break up the centre as a home of families and strengthen the periphery, and growth of towns is followed by loss of flexibility; the built-up block becomes,

in the social sense, little more than that which divides two streets. The Grand Place of Brussels on the other hand is that which gives breathing space to a group of buildings full of social significance and dignity. Our emphasis on the street is probably a legacy from Haussmann, whose work in Paris Sir Patrick Geddes used to criticize. Spengler too pointed out the evil of these schemes when he said that a great part of the *cives Romani* of antiquity possessed no more than a high-priced sleeping berth in one of the "swarming anthills," a criticism still applicable to our cities. Gutkind pleads for more intimate coadaptation between man and nature; appropriately St. James's Park contrasts with the palace gardens of the Baroque. He sees that conditions and needs develop and he asks for houses as short-term consumers' goods, but begs for their incorporation in a social unit in order that we may recover from the atomization of man in the crowd, a mass without form or order, difficult to move save through transient emotion, often of fear or hate. All through this book the author draws parallels between musical and social evolution, but it would take much space even to summarize his interesting comments in this connection. One of Gutkind's dreams is of an International Society of about one hundred fellows elected for eminent achievements, clear proposals that have stood scrutiny, and outstanding quality of character and mind. He knows it would be difficult to create.

In the second and longer section of the book, the author gives critical surveys of planning in Jesuit Paraguay, Marxist-Leninist Russia, and ageless China. Paraguay seems to him to have been a benevolent dictatorship with an attempt to surround it by an impenetrable curtain. He sees that it broke down; he might have said that, like the old *Missiones* of California, it tended to keep the people too dependent in mind. He notes very specially that the town in China does not get the upper hand as it does in Europe. He believes that the mother is the centre of Chinese life in a population which has been an immense group of families that have had considerable self government. The conception of community apart from family is here said to have had little influence in China; even the village was basically the home of the clan, very informally governed. Old censuses gave the number of families and, on that basis, Gutkind estimates that until the Ming the population of China probably never reached 60 million; but that by the end of the Ming period in the mid-seventeenth century it had more or less stabilized itself at about 150 millions, to begin expanding again rapidly from the late eighteenth century onwards. Cressey makes growth of population, from a 60-million basis, start in the seventeenth century and accelerate chiefly in the nineteenth; his estimate for the end of the Ming period would be about 100 millions. In North China the silhouette of the town wall is the dominant urban feature and the town is traditionally limited and systematic with houses as the primary and streets only as secondary elements, though locations of diverse trades along different streets is a feature, as it is in India and as it was in medieval Europe.

Gutkind thinks the historic expansion of Russia was founded on the desire to conquer, save perhaps among the Finnish populations. The town was a fortified centre held by the conquerors; the revolution of 1917 made it an industrial centre. The new Russians follow the line of maximum productivity, not that of least resistance, and in this book the author says all he can on their behalf, yet hopes that the "invisible frontier between Russia and the rest of the world may fall definitely and for ever." The book was largely written before the war ended and the separation of Russia from the West had become the dominant note of Soviet propaganda, anxious lest the power of the Politburo should be diminished.

There may be many reserves in a reader's mind about some of Gutkind's views.

Yet we can all appreciate his historical surveys of Paraguay, Russia and China, and many recall with gratitude his efforts, sometimes controvertible, to illuminate demographic and social problems. H. J. F.

WORLD FIBER SURVEY. Washington: Food and Agricultural Organization of the United Nations, 1947. 9×6 *inches;* xii+186 *pages; diagrams.* 5*s*

This work deals with the economic aspects of the world production and consumption of fibres. The first part gives accounts of fibres in the world economy, of consumption in relation to real-income levels of various countries, and of the short-term and long-term outlook in the supply of fibres. The future for natural fibres is discussed in terms of the greater stability of prices among man-made fibres, and of the competition between fibres and food crops for cultivable land. The second part, which takes up the greater portion of the book, deals with the more important natural fibres. Introductory paragraphs sketch the climatic and other conditions necessary for production, but most space is given to accounts of trade and consumption. Of special interest to geographers are the discussions, such as the one on the economic and social consequences of the complete mechanization of cotton cultivation. A shorter section deals with man-made fibres. The statistical material, which includes the most recent data, is of special value to the economic geographer. R. R. R.

GENERAL

GEOGRAPHY AND AIR PHOTOGRAPHS. By DAVID L. LINTON. *Manchester: Geographical Association,* 1947. 9½×6 *inches;* 32 *pages.* 1*s* 8*d*

The value of air photographs for teaching any subject with topographical connections is now widely recognized, and increasing use is being made of such photographs for illustrations in textbooks. Air photography can be a most effective means of introducing young people to scenes and environments with which they are quite unfamiliar. As Professor Linton points out, the use of air photographs for teaching in schools and universities requires that suitable photographs should be available in quantity and at reasonable cost. The formation of a national library of air photographs such as that already established in Canada is a project for which there is a growing public demand. The value to geographers of the vast photographic collections of the Royal Air Force has still to be assessed. Important material must be included in these archives, and it is most desirable that this should be preserved and that scientific and educational bodies should be able to make effective use of it subject to security requirements. Already limited access by the public is permitted to part of the collections, while prints from the photographic survey of this country are supplied at the very reasonable cost of 10*d*. a print.

The most interesting part of this paper is the third section which describes the use of air photographs in geographical research. Air photography is a uniquely effective way of illustrating many different aspects of geography and is of very special interest to the geomorphologist. A collection of detailed photographs taken specifically for the purpose would form an invaluable basis for teaching and research. J. K. St. J.

ADDITIONS TO THE LIBRARY AND MAP ROOM

EUROPE

LONDON 200 YEARS AGO

By W. Crawford Snowden. With introd. by E. G. R. Taylor. 11×9. 64 pp. and facsimile map. *London: Daily Mail*, 1948. 7s 6d

John Rocque's map of London, 1746, is reproduced in 24 sections with commentary and illustrations of contemporary life. The text carefully traces the changes in buildings and street plan, but does not bring out the relation of the 'quarters' to each other, and the differentiation in their functions.

THE COTTON INDUSTRY IN BRISTOL

By S. J. Jones. (*Trans. Inst. Brit. Geogr.* 1947, 61–79)

THE HIGH LEVEL GRAVELS IN EAST AND NORTH DEVON

By R. Pickard (*Rept. & Trans. Devonshire Assocn.* 78 (1946) 207–28)

THE SUBMERGED FOREST BEDS OF THE DURHAM COAST

By C. T. Trechmann (*Proc. Yorks. Geol. Soc.* 27 (1947) 23–32; sketch-maps and illustrations)

THE CHALKY BOULDER CLAYS OF NORFOLK AND SUFFOLK

By D. F. W. Baden-Powell. (*Geol. Mag.* 85 (1948) 279–96)

OXFORD REPLANNED

By Thomas Sharp. 9×7. 224 pp. Maps and illustrations. *London: Architectural Press (for Oxford City Council)*, 1948.

The outline plan prepared by the Planning Consultant, recommending the removal of the two large industrial organizations to another part of the country, and the restriction of the City to slightly less than its present size.

THE REGIONAL GEOGRAPHY OF THOMAS HARDY'S WESSEX

By H. C. Darby. (*Geogr. Rev.* 38 (1948) 426–43)

THE SEQUENCE AND STRUCTURE OF THE SOUTHERN PORTION OF THE EAST CROP OF THE SOUTH WALES COALFIELD

By L. R. Moore (*Quart. J. Geol. Soc.* 103 (1948) 261–300; diagrams)

PREHISTORIC GOWER: THE EARLY ARCHAEOLOGY OF WEST GLAMORGAN

By J. G. Rutter. 8½×6. 90 pp. Sketch-maps and illustrations. *Swansea: Welsh Guides*, 1948. 10s 6d

THE DEGLACIATION OF SCOTLAND AND THE FORMING OF MAN'S ENVIRONMENT

By A. D. Lacaille. (*Proc. Geol. Assocn.* 59 (1948) 151–71; maps)

EDINBURGH

By Sacheverell Sitwell and Francis Bamford. (*Library of Art and Travel.*) 9×6. 248 pp. Illustrations. *London: John Lehmann*, 1948. 12s 6d

A history of the city to the visit of George IV. mainly political, but with observations on architecture and art, and on social life.

SOUTH SLESVIG

By H. Stegmann. (*Scottish G. Mag.* 64 (1948) 7–15; sketch-maps.)

L'AUVERGNE ET LE VELAY

By Lucien Gachon. (*Les provinces françaises*, 1.) 9×5½. 344 pp. Illustrations and map. *Paris: Gallimard*, 1948.

The first volume in a series dealing with the traditional life, customs and folklore of the French provinces.

HAUTE DURANCE ET UBAYE

By C. P. Péguy. (*Rev. Géogr. Alpine* 35 (1947) 389–522; 585–737; maps and illustrations)

A detailed study of the structure, climate and hydrology of the upper Durance basin

LA RÉGION DE CONTACT ENTRE LA LIMAGNE ET LE NORD DU LIVRADOIS

By J. Delaspre. (*Rev. Géogr. Alpine* 35 (1947) 523–69)

LE PLATEAU DE VALENSOLE

By J. de Beauregard. (*Rev. Géogr. Alpine* 35 (1947) 63–110)

Study of a region in Provence transitional between the Rhône valley and the pre-Alps

FAHRTEN IN ISLAND

By Rudolf Jonas. 9×6. 198 pp. Illustrations and maps. *Wien: L. W. Seidel*, 1948. $3.50

The book includes an account of the Austrian Iceland–Vatnajökul expedition, 1935

GRUNDZÜGE EINER OBERFLÄCHENGESTALTUNG SÜDNORWEGENS

By W. Evers. (*Deut. Geogr. Blätter* 44 (1941) 1–158; illustrations and diagrams)

ON THE CLIMATE OF THE LOFTY MOUNTAIN REGION OF SOUTHERN NORWAY

By F. Spinnangr and O. Eide. (*Meteorol. Annaler*, 2 (1948) 403–64)

NUEVAS APORTACIONES AL CONOCIMIENTO GEOMORFOLOGICO DE LA CORDILLERA CENTRAL

By C. Vidal Box. (*Estudios geogr.* 9 (1948) 5–52; maps and illustrations)

ISRECESSIONEN FRÅN NORRBOTTENS KUSTLAND

By G. Hoppe. (*Geographica*, no. 20 (1948) 112 pp.; maps and illustrations)

NORRLAND: NATUR, BEFOLKNING OCH NÄRINGAR

$6\frac{1}{2} \times 9\frac{1}{2}$. 594 pp. Maps and illustrations. *Stockholm: Industriens Utredningsinstitut*, 1942

KRETA: DIE INSEL IM HERZEN DER ALTEN WELT

By Erwin Stürzl, with photographs by A. Feichtenberger. 9×6. 154 pp. Map and illustrations. *Wien: L. W. Seidel*, 1948. $4

From extensive wanderings throughout the island, the author describes the landscape, history, social life and folklore of the people. Four of the hundred illustrations are in colour

LE ISOLE DALMATE

By Mario Ortolani. (*Riv. G. Ital.* 55 (1948) 186–203)

ASIA

LANDSCHAFTSKUNDLICHE BEOBACHTUNGEN IM SUDLICHEN HEDJAZ

By C. Rathjens and H. von Wissmann. (*Erdkunde, Bonn*, 1 (1947) 61–89

THE MURIA AND THEIR GHOTUL

By Verrier Elwin. $10 \times 6\frac{1}{2}$. xxx+730. Maps and illustrations. *Oxford Univ. Press* (*pr. Calcutta*), 1948. 42*s*

The Muria are a tribe of Bastar State, and the ghotul is the "bachelors' hall," one of the most highly developed in the world, and the centre of social and religious life

AN INTRODUCTION TO PAKISTAN: ITS RESOURCES AND POTENTIALITIES

By M. B. Pithawalla. 9×6. iv+100 pp. Maps. *Karachi*, 1948. Rs. 5

ADAT LAW IN INDONESIA

By B. ter Haar. $8 \times 5\frac{1}{2}$. xiv+226 pp. *New York: Inst. of Pacific Relations*, 1948. $4.00

A study, translated from the Dutch, of native customs that have legal consequences in relation to the modern legal system

AFRICA

GEOLOGIA DELL'AFRICA ORIENTALE. 4 vols.

By Giotto Dainelli. (*R. Ac. d'Italia: Centro Studi per l'Africa Orient. Ital.*, 7) 9×6: vol. 1: 464 pp.; 2: 704 pp.; 3: 748 pp.; 4: Maps. *Rome*, 1943

The first volume traces the development of geological knowledge of Ethiopia and Somaliland; the second deals with the crystalline basement and the mesozoic sedimentary series, the third with the tertiary and quaternary. The geological map, which was the original objective of the study, is on the scale of 1/2 M.

THE GOVERNMENT OF ETHIOPIA

By Margery Perham. $9 \times 5\frac{1}{2}$. xxiv+482 pp. Maps. *London: Faber*, 1948. 30*s*

An examination of the institutions of government in 1935, with an historical introduction, and of developments under Italian rule and since the restoration in 1941.

THE GEOLOGY OF THE COUNTRY AROUND MWANZA GULF

By G. M. Stockley. (*Tanganyika Ter., Geol. Div., Short paper* 29 (1947) 26 pp.; map)

A REVIEW OF SOME VEGETATIONAL STUDIES IN UGANDA

By W. J. Eggeling. (*Uganda J.* 12 (1948) 139–52)

TIME LONGER THAN ROPE: A HISTORY OF THE BLACK MAN'S STRUGGLE FOR FREEDOM IN SOUTH AFRICA

By Edward Roux. $8 \times 5\frac{1}{2}$. 398 pp. Illustrations. *London: Victor Gollancz*, 1948. 18*s*

Mainly a political history, but with an economic and social background. The greater part deals with events since 1906. The possible emergence of a liberal industrial party would at least offer the prospect of physical salvation and of ultimate political and spiritual emancipation to the black man

REPORT ON THE GEOLOGY OF BASUTOLAND

By G. M. Stockley. 9×6. viii+114 pp. Maps and illustrations. *Maseru: Comptroller of Stores*, 1947. 10*s*

The results of a reconnaissance geological survey carried out in 1938–40. Included is a geological map on the scale of 6 miles to 1 inch

NORTH AMERICA

SIMPSON'S 1828 JOURNEY TO THE COLUMBIA

Ed. by E. E. Rich. (*Champlain Soc. Publn.; Hudson's Bay Co. Series*, 10.) $9^{1}/_{2} \times 6^{1}/_{2}$. lii+278 pp. *Toronto*, 1947

The first publication of Governor George Simpson's despatch dealing with his journey from Hudson Bay to the Pacific in 1828, which is important in relation to the Oregon boundary controversy

PROVINCE OF ALBERTA: GEOGRAPHICAL ASPECTS

By G. F. McNally. (*Canadian Géogr. Soc.*) $10^{1}/_{4} \times 7^{1}/_{2}$. 32 pp.; map and illustrations. *Ottawa, n.d.*

One of the 'Provincial Series' prepared specially for students

GIANT GLACIAL GROOVES IN NORTHWEST CANADA

By H. T. U. Smith. (*Amer. J. Science* 246 (1948) 503)

Some of these grooves are 100 feet deep and up to 1 mile in length: their trend is unrelated to structure or drainage

MONTRÉAL: ESQUISSE DE GÉOGRAPHIE URBAINE

By Raoul Blanchard. (*Rev. Géogr. Alpine* 35 (1947) 133–328; illustrations and plans)

A study of the growth and present activities of the Montreal agglomeration, which has a population approaching 1,300,000. The preponderance of the French is traced to the twentieth century industrialization

THE PENETANGUISHENE PENINSULA

By W. C. Wonders (*Canadian G. J.* 37 (1948) 118–29; illustrations)

The peninsula in Georgian Bay, Lake Huron, occupies a key position in the Great Lakes transport system

POLLEN DIAGRAMS FROM LABRADOR

By Carl-Gosta Wenner. (*Geogr. Ann.* 29 (1947) 137–372; illustrations and diagrams)

A HISTORY OF POPULATION GROWTH IN THE UNITED STATES

By P. K. Whelpton. (*Sc. Monthly* 67 (1948) 277–88)

SOUTH AMERICA

CONTRIBUTION À LA MORPHOGRAPHIE DE L'ÎLE DE SANTO DOMINGO

By F. Guerra Pena. (*Rev. Soc. Haitienne de G.* 19 (1948) 1–5; map)

VEGETATION AND LAND USE IN THE PLANALTO CENTRAL OF BRAZIL

By L. Waibel. (*Geogr. Rev.* 38 (1948) 529–54; illustrations)

TOPOGRAFISCHE OBSERVATIES BIJ TWEE VERKENNINGSVLUCHTEN BOVEN NOORDELIJK SURINAME

By D. C. Geijskes and H. Schols (*Tijds. K. Nederl. Aardr. Gen.* 65 (1948) 342–53; illustrations)

A WANDERER IN INCA LAND

By Christopher Sandeman. $11^{1}/_{2} \times 9$. 192 pp. Illustrations and map. *London: Phoenix House*, 1948. 45*s*

Eighty-nine full page photographs taken by the author between 1938 and 1946, with notes on each. They cover all aspects of the scenery, daily life and history of Peru. The author described one of his numerous journeys in the *Geogr. Journ.* 105 (1945) 81

LA HILEA AMAZONICA PERUANA

By V. M. Pinedo. (*Bol. Soc. G. Lima* 64 (1948) 14–24)

CLIMA, DESAGÜE Y AGUAS SUBTERRANEAS EN LA ARGENTINA

By Juan Keidel. (*Inst. Estudios Geogr., Tucumán*; *Monogr.* no. 10 (1948) pp. 74; illustrations)

IN ARGENTINE TIERRA DEL FUEGO: NOTES ON A TOUR

By J. E. Church. (*Geogr. Rev.* 38 (1948) 392–413; illustrations)

LAND OF THE CONDOR

By Hakon Mielche. $8^{1}/_{2} \times 6$. 252 pp. Illustrations. *London: Wm. Hodge*, 1947. 12*s* 6*d*

The narrative of a journey from south to north through Chile, which conveys a good deal of information in a light-hearted way

AUSTRALASIA AND PACIFIC

DESERT JOURNEYS

By Geoffrey Rawson. 8×6. 270 pp. Sketch-maps. *London: Jonathan Cape*, 1948. 12*s* 6*d*

Accounts of the exploration of Central Australia in 1873–74 by expeditions led by Warburton, Forrest and Giles to find a practicable route from east to west. A general map showing the relations of the three routes would have been useful.

THE GEOLOGY OF THE COUNTRY AROUND TARRALEAH, TASMANIA

By R. T. Prider. (*Papers & Proc. R. Soc. Tasmania* 1947, 127–50; map and illustrations)

BOOMER MARSH: A PRELIMINARY BOTANICAL AND HISTORICAL SURVEY

By W. M. Curtis and J. Somerville. (*Papers & Proc. R. Soc. Tasmania*, 1947, 151–57)

Claims that the evidence presenetd here shows that the Dutch landing in 1642 was made at Boomer Creek

THE HANMER PLAIN AND THE HOPE FAULT

By C. A. Cotton. (*N.Z. Journ. Sc., Gen. Section* 29 (1947) 10–17; illustrations)

MICROSEISMS AND PACIFIC TYPHOONS

By Marion H. Gilmore and W. E. Hubert. (*Bull. Seismolog. Soc. America* 38 (1948) 195–228)

A CHRONOLOGY OF THE EXPLOSIVE ERUPTIONS OF KILAUEA

By H. A. Powers. (*Pacific Science* 2 (1948) 278–92; illustrations)

LANDOWNERSHIP ON A MICRONESIAN ATOLL

By R. E. Murphy. (*Geogr. Rev.* 38 (1948) 598–614; illustrations)

POLAR REGIONS

DIE KLIMA-MORPHOLOGISCHEN ZONEN DER POLARLÄNDER

By J. Büdel. (*Erdkunde*, Bonn, 2 (1948) 22–53; illustrations)

AVIATION IN ARCTIC NORTH AMERICA AND IN GREENLAND

By Trevor Lloyd. (*Polar Record* 5 (1948) 163–71)

CRYOLITE AND THE MINE AT IVIGTUT, WEST GREENLAND

By J. G. Elbo. (*Polar Record* 5 (1948) 185–8; illustrations)

GLACIER RETREAT IN JAN MAYEN

By J. N. Jennings. (*J. of Glaciology* 1 (1948) 167–81; illustrations)

THE ANTARCTIC PACK ICE

By H. F. P. Herdman. (*J. of Glaciology* 1 (1948) 156–66)

RONNE ANTARCTIC RESEARCH EXPEDITION 1946–48

By Finn Ronne. (*Geogr. Rev.* 38 (1948) 355–91; maps and illustrations)

THE TRUE LOCATION OF STEFANSSON STRAIT AND HEARST LAND, ANTARCTICA

By K. J. Bertrand, W. L. G. Joerg, and H. E. Saunders. (*Geogr. Rev.* 38 (1948) 475–86)

GENERAL

AN INTRODUCTION TO MAP PROJECTIONS

By A. D. Merriman. 9½×7. 112 pp. Diagrams. *London: Harrap*, 1947. 7s 6d

IL PAESAGGIO TERRESTRE

By Renato Biasutti. 10×7. 380 pp. Illustrations. *Torino: Unione Tipografico*, 1947

A systematic study of the surface phenomena combining to form the landscapes of the world, for university students. Includes a discussion of various suggested regional classifications based on climate, vegetation and morphology

DER ASYMMETRISCHE VEGETATIONS- UND LANDSCHAFTSBAU DER NORD- UND SÜDHALBKUGEL

By C. Troll. (*Göttinger Geogr. Abhandl.* 1 (1948) 11–27; diagrams)

VALLEY STEPS AND GLACIAL VALLEY EROSION

By W. V. Lewis. (*Trans. Inst. Brit. Geogr.* 1947, 19–44; illustrations)

DIE SUBNIVALE ODER PERIGLAZIALE ZYKLUS DER DENUDATION

By C. Troll. (*Erdkunde, Bonn*, 2 (1948) 1–21)

L'INFLUENCE DE LA TECTONIQUE RÉCENTE SUR LA MORPHOLOGIE

By J. B. L. Hol. (*Bull. Soc. R. Belge de Géogr.* 72 (1948) 9–30)

SEQUENCE IN LAYERED ROCKS

By R. R. Shrock. 9½×6½. xiv+508 pp. Illustrations. *New York: McGraw-Hill*, 1948. 45s

The sub-title is "a study of features and structures useful for determining top and bottom or order of succession in bedded and tabular rock bodies."

ALLGEMEINE GEOGRAPHIE DES MENSCHEN. 1. BD. DIE MENSCHEIT: GRUNDLEGUNG DER GEOGRAPHIE DES MENSCHEN

By Alfred Hettner. 9½×7. xxxiv+324 pp.; diagrams. *Stuttgart: W. Kohlhammer*, 1947. R.M. 18

This work, which was practically finished by Hettner before his death, has been edited with a memoir by H. Schmitthenner. Four further volumes are in preparation. The whole was designed as a complement to his 'Vergleichende Geographie.' He envisages man as bound to the natural environment, but consciously reacting to it. The present volume deals largely with the development of cultures (or civilizations) and their spread over the surface of the earth

THE HEATHENS: PRIMITIVE MAN AND HIS RELIGIONS

By William Howells. 9×6. 268 pp. Illustrations. *London: Victor Gollancz*, 1948. 18*s*

Prof. Howells gives the modern anthropological attitude to primitive religions: "religious ideas help in the struggle for existence as verily as a bow and arrow or a fish trap."

A SHORT HISTORY OF THE MIDDLE EAST FROM THE RISE OF ISLAM TO MODERN TIMES

By George E. Kirk. 9×6. x+302 pp. Sketch-maps. *London: Methuen*, 1948. 16*s*

"Middle East" is here taken to cover the Arabic-speaking lands and their northern neighbours Anatolia and Persia. The author keeps economic and social conditions well to the fore

GEOGRAPHY AND POLITICS; THE GEOGRAPHICAL DOCTRINE OF BALANCE

By J. N. L. Baker. (*Trans. Inst. Brit. Geogr.* 1947, 1–18)

ATLASES AND MAPS

GENERAL

WESTERMANNS ATLAS. Heimat und Welt. *Braunschweig: Georg Westerman*, 1948

A small atlas of physical maps.

ADMIRALTY CHARTS. 6 New Charts. 6 New Editions. 28 Charts which have received Large Corrections. 1 "Decca" Lattice Chart. *London: Hydrographic Dept., Admiralty*, 1948

EUROPE

GREAT BRITAIN. Ordnance Survey. Six-inch Map. 94 sheets, *price* 2*s. per sheet*. —Provisional edition on National Sheet Lines, sheet 51/27 NW, *price* 4*s*. 1:25,000 or about $2^1/_2$ inches to 1 mile, 34 sheets, *price* 2*s. per sheet. Chessington*, 1948

GREAT BRITAIN. Geological Survey of England and Wales. 1:63,360. Sheets, Drift: 28, 76, 169, 254, 325, 337, Solid 76. *London*, 1948

GREAT BRITAIN. Administrative Diagram of Lincolnshire. 1:126,720. *Chessington: Ordnance Survey*, 1948. 4*s* 6*d*

GREAT BRITAIN. Land Utilization Survey. Sheets, England: 3, 8 and 18, part of 15, 17, 79, 89, 90; Scotland, 64, 66, 67, 81, 82, 88, 89, 90. *London*, 1948. *Price* 5*s. per sheet*

DENMARK. Erhvervsgeografisk Kort over Danmark, 1:300,000. *Copenhagen: Geodaetisk Institut*, 1948

NORWAY. Landgeneralkart over Norge i 1:250,000. Sheets: 30, 35, 40. *Oslo: Norges Geografiske Oppmåling*, 1946–45

POLAND. Geological Map of Poland, 1:25,000. Sheet: Dabrowa Górnicza. 1:300,000. 3 sheets. *Warsaw: Geological Survey of Poland*, 1948

ASIA

CEYLON 1:253,440. *Colombo: Survey Dept.*, 1947

A layer coloured map in four sheets

AFRICA

AFRICA: Carte Géologique Internationale de l'Afrique. 1:5,000,000. Sheet 4. *Paris: Bureau d'Études Géologique et Minières Coloniales*, 1948

ANGLO-EGYPTIAN SUDAN. International Map of the World. 1:1,000,000. Sheet: N.D.-35. 1:250,000. Sheets: 45-I, 55-J. *Khartoum: Survey Dept.*, 1948

ANGLO-EGYPTIAN SUDAN. Upper White Nile Air Survey. 1:50,000. 12 sheets. *Khartoum: Inspector General of Irrigation*, 1948

GAMBIA 1:50,000. Sheets: 1, 2, 11, 15. *Teddington: Directorate of Colonial Surveys*, 1948

GOLD COAST. Volta River Area 1:5,000. 19 sheets. *Teddington: Directorate of Colonial Surveys*, 1948

SIERRA LEONE 1:10,000. Sheets: 7, 8, 13, 14. *Teddington: Directorate of Colonial Surveys*, 1948

UNION OF SOUTH AFRICA. Geological Survey, 1:125,000. Sheet 64; 1:75,000 Geological Map of the Ermelo Coal Field, S.E. portion. *Pretoria: Dept. of Mines*, 1948

NORTH AMERICA

NORTH AMERICA. Geologic Map compiled by George W. Stose. 1:5,000,000. 2 sheets. *New York: American Geological Society*, 1946

UNITED STATES, SOUTH-WESTERN. 1:2,500,000. *Washington: National Geographic Society*, 1948

THE SOCIETY'S NEWS

NORWEGIAN – BRITISH – SWEDISH EXPEDITION TO THE ANTARCTIC

Since 1946, plans have been developed for a joint scientific exploration of Queen Maud Land, the part of Antarctica which lies between longitude 20° W. and 45° E. and which is bounded to the west by the Falkland Islands Dependencies and to the east by the Australian Antarctic Territory. The expedition will sail from Norway about the middle of November 1949 with a party of fourteen men, scientists and technicians who will spend two years in the Antarctic. An international expedition along these lines represents an entirely new venture in international scientific cooperation.

The first contribution towards the preparation of the expedition was made through the Royal Geographical Society from the Geographical Magazine Trust Fund for exploration and research which enabled £2000 to be placed at the disposal of the preliminary international organizing committee. In June 1948 the Norwegian Parliament allotted a further sum of £10,000 and in addition invited the British and Swedish Governments to participate in the expedition by nominating specialists as members and by contributing scientific and polar equipment. The British Government has since made a contribution of £20,000 for these purposes and a similar contribution has been made by Sweden. The total cost of the expedition, including the cost of publishing the scientific results, is estimated at about £150,000 of which the Norwegian Government is prepared to carry the greater part.

The Norwegian Polar Institute will be responsible for transporting the expedition to the Antarctic and will also undertake an air survey of Queen Maud Land in 1950–51. The scientific work of the shore party will be divided equally between the three participating nations, Great Britain being responsible for the geological work, Sweden for the glaciological research, and Norway for the meteorological investigations.

During the first season, 1949–50, efforts will be concentrated on establishing the wintering party on the antarctic mainland. A small Norwegian sealer is being chartered to carry the party south, and help in transportation will be sought from Norwegian whalers operating off the coast. The sealer will be large enough to carry a helicopter or aircraft which should prove invaluable for reconnaissance purposes. Thorough reconnaissance will be essential since the whole coast is covered by glacier ice which is full of dangerous crevasses. Air photographs taken just before the war show, however, that in some places the glacier ice slopes gently down to sea-level. In these places, the ice may be stable and permit the safe erection of timber houses which the expedition will bring south with them. The present plan is that these houses and all the equipment should be landed directly from the sealer late in the season when the sea ice has been carried away. The helicopter or aircraft will probably be of great use in landing some of the considerable quantity of equipment which the expedition will need to carry.

During the season 1950–51 the coast of Queen Maud Land will again be visited by a Norwegian ship, this time carrying an aircraft for the air survey programme. During this second season, parties will travel from the base station, using dog teams and mechanized snow vehicles known as "weasels," to explore the remarkable snow-free and ice-free regions that were first revealed in air

Photographic News Agencies

"Navigation through the ages." H.R.H. The Duke of Edinburgh looking at compasses in the historical section

Phots. Keystone Press Agency

Two exhibits from the National Maritime Museum: Kendall's copy (1769) of Harrison's fourth chronometer, used by Cook; and, below, Drake's dial made by Humphrey Cole in 1569. (Both about two-thirds actual size)

photographs taken in January 1939. This ground exploration will be concluded in the early part of the 1951–52 season, and in January or February 1952 the party will sail for home. Throughout the expedition's stay in the Antarctic, comprehensive meteorological investigations will be made, using the latest instruments and techniques such as radio sonde and radar. Daily weather reports will be sent out probably *via* Port Stanley in the Falkland Islands. These will be coordinated with the weather reports of the British Falkland Islands Dependencies Survey expedition.

The wintering party will be under the leadership of Captain John Giaever of the Norwegian Polar Institute. It will include at least two scientists from each of the three participating countries as well as technical personnel, partly from Great Britain and Sweden but mainly from Norway.

These and other plans for the expedition have been discussed at recent meetings in London and in Cambridge which were attended by representatives of the Norwegian Polar Institute, the Swedish Geographical Institute, the Royal Geographical Society, and the Scott Polar Research Institute. The organization of the British share of the expedition is being conducted by the Joint Polar Committee of the Society and of the Scott Polar Institute under the chairmanship of Mr. J. M. Wordie. The headquarters of the expedition in this country will be at the Society's House.

NAVIGATION THROUGH THE AGES

The Christmas exhibition "Navigation through the ages," held jointly by the Institute of Navigation and the Society, was the first ever held to trace the development of navigation from its early days to the present time. Nearly four hundred exhibits lent by the National Maritime Museum, the Science Museum, the Royal Greenwich Observatory, and a large number of societies, commercial firms and individuals, were arranged to show the historic changes in navigation methods and instruments and especially Great Britain's leading share in their development. Among the early exhibits were some of the oldest known Portulan charts and astrolabes dating from the fifteenth century; "Drake's dial," a compendium of instruments made by Humphrey Cole in 1569; a telescope by Maria de Rheita dated 1645; and Kendall's copy (1769) of Harrison's fourth chronometer, which was taken by Captain Cook on the second of his great voyages. The spectacular developments of the last few decades, resulting from the special needs of the air navigator, the application of radio to navigation and the rapid development of radar during the war, were represented by a wide selection of instruments. The practical application of modern aids to navigation was demonstrated by a model of the complex traffic control system for the Berlin air lift, and others of the Liverpool Harbour Supervision and the Wallasey Ferry radar sets installed this year, the first of their kind.

Opening the exhibition on December 17, H.R.H. The Duke of Edinburgh said: "Ladies and Gentlemen—In the first place, I would like to thank both the Royal Geographical Society and the Institute of Navigation for asking me to open this exhibition and also for the very kind way in which they asked me to do so. Secondly, I would like to congratulate the founders of the Institute of Navigation not only on founding the Institute but on the initial success which they have had. The mere fact that they have organized this exhibition shows the amount of enthusiasm there is in the Institute. As to navigation itself, I do not know how many of you have a first-hand knowledge of it, but I have been the butt of it for some years. I would like to say that it brings together, apart from the scientific side of which we have heard to-night, the merchant seaman who is a professional navigator, the Royal Naval navigator who is

almost an experimenter in marine navigation and is an entirely different creature; and it brings together with them the air side of navigation, the R.A.F. who have one set of problems to contend with and the civil aviator who has an entirely different set of problems to solve, bound up largely with extra special safety and continuous running. And last of all, into this mixture it brings the amateur yachtsman who, I think, prides himself on the minimum of aids to navigation which he uses. Finally, I would only like to add that I think it most fitting that this exhibition should be held in the house of the Royal Geographical Society because, after all, the explorers and researchers geographically owe an enormous debt to the navigators of the past." Sir Harry Lindsay, President of the Society, and Sir Harold Spencer-Jones, Astronomer Royal and President of the Institute of Navigation, read addresses of welcome.

More than 15,000 people including 70 schools visited the exhibition during the six weeks that it remained open.

THE RECORD

WHITBECK FELLOWSHIPS IN GEOGRAPHY

The University of Wisconsin is offering two Whitbeck Fellowships for the academic year 1949–50. Applications from abroad are invited and should reach the university authorities as soon as possible. They are open to men and women graduates who have completed the equivalent of an ordinary four-year undergraduate course in America. Though usually granted for one year only, they may be extended for a second year. The fellowships carry an enhanced stipend of $1000, which is intended to defray living expenses during the 10-month academic year and is not expected to cover the cost of travel to and from the United States or any additional expenses. Whitbeck Fellows are expected to spend the period covered by their fellowships in residence at the University of Wisconsin. Further particulars about applications may be obtained from the Society.

UNIVERSITY NEWS

UNIVERSITY OF TORONTO

With the large influx of veterans the young Department of Geography grew rapidly to a total register of 1350 students in 1947–48. The number of freshmen is lower now, and the total figure is just short of a thousand. Of this number, 50 are taking Honour Geography (a three-year course) and 20 are doing post-graduate work in geography. The Honour school owes much to the enthusiasm of Dr. Tatham and Dr. Putnam and greatly increases their responsibilities. Last summer both were promoted to Associate Professors. Dr. Tatham is specializing in political geography and philosophy of geography; while Dr. Putnam is an expert in agricultural geography. Owing to the greatly increased numbers in Honour Geography the Council appointed two new lecturers; while Mr. Wonders replaced Professor Reeds (now at McMaster). Mr. Wonders has just returned from a summer spent far north of the Arctic Circle. He made a number of flights to the islands of the archipelago and reached Thule in Greenland. Mr. Spelt graduated from the University of Utrecht and strengthens

Graphic Photo Union

Phot. Samson Clark and Co.

Aids to navigation to-day

the department in regard to continental geography and literature. Mrs. Beryl Bird is a distinguished graduate of the Cambridge school of geography. She has recently spent the summer in northern Keewatin in a party of four geographers led by her husband Brian Bird, who is also a lecturer in the department. For some months they lived on caribou meat, seeing no folk but occasional Eskimos. The total staff including all instructors now amounts to twenty-six.

GRIFFITH TAYLOR

MCGILL UNIVERSITY, MONTREAL

The second session of the Geography Summer School (inaugurated in 1947) was held at Stanstead College, Quebec, from July 5 to August 14. Thirteen courses were offered and the staff included Dr. L. D. Stamp from the London School of Economics, Dr. R. E. Dickinson from Syracuse University, Colonel P. D. Baird and Sir Hubert Wilkins from the Arctic Institute of North America, Dr. N. E. Odell from Cambridge University, Dr. J. W. Coulter from the University of Cincinnati, Dr. P. Dansereau of the Service de Biogéographie, Université de Montréal, Dr. B. Zaborski formerly of the Polish University College, London, and Dr. V. Stefansson, editor of *Encyclopaedia Arctica*. The 93 students attending the school were drawn from all parts of the North American continent and England, and included representatives from the Armed Forces of both Canada and the United States.

The Committee on Physical Planning (established in 1940) in the faculty of Graduate Studies and Research has recently instituted a two-year post-graduate course for which five fellowships of $1000 each have been made available. The prescribed course of study includes planning, public finance, fiscal policy, practical geography and sociology. The chairman of the committee is Professor H. J. Spence-Sales, Associate Professor of Architecture (formerly of the Ministry of Town and Country Planning), and the committee includes representatives from the departments of Sociology, Economics and Geography (Professor F. K. Hare).

During the past year Professor Hare has been carrying out research for the Federal Government on the dynamic and physical climatology of the eastern Canadian Arctic and Subarctic. Both he and Miss M. Montgomery, who is assisting him, have made several visits to the Canadian Arctic. One of these was with Operation Cariberg, an air expedition which had as its dual objects a caribou census and an investigation of ice conditions in Hudson Bay.

Professor Ross Mackay has been engaged on a regional survey of the Ottawa valley and has also been studying recent colonization in the Lake Baskatong area north of Ottawa. Experimenting with dot-maps, he has perfected a technique which obviates guess-work in the selection of the correct dot-size and of the appropriate unit-dot value.

Graduate students currently working in the department include Mr. J. M. Roy who will shortly join the staff of Laval University's new geography department, and who is writing a thesis on the historical geography of the Lower St. Lawrence; Mr. H. N. Lash who is experimenting with methods of land utilization survey suited to eastern Canada; Mr. J. R. Purves-Smith who is working on the geography of Southampton Island; and Mr. J. Taylor and Mr. P. E. Uren who are engaged on regional surveys of Île Jésu and the St. Maurice valley respectively.

Professor George H. T. Kimble, chairman of the department, has been appointed Visiting Professor at the University of California, Berkeley, for the first half of the 1948–49 session. Dr. B. Zaborski has been appointed Visiting Professor at McGill in his absence. Dr. Zaborski, who was Professor of Geo-

graphy at the University of Warsaw before the war, has recently been awarded a Lady Davis Fellowship which will enable him to carry out a programme of research at McGill during 1949.

Dr. A. Lincoln Washburn, Director of the Arctic Institute of North America and honorary lecturer in the department, is conducting a graduate seminar on the geography of the Arctic during the present session. P. E. U.

UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER

This university has grown from a total student body of some 2500 in 1939 to nearly 8800 for the current session. Consequently the twin problems of population pressure and of accommodation have become acute and have only in part been solved by a vigorous campaign of hutment erection. More permanent buildings are however nearing completion to meet the needs of an anticipated future enrolment of some 5000.

Geography is under the wing of geology, and while the general organization of the teaching is left in the hands of an associate professor of geography, the guiding hand of Geology in the person of the senior professor (M. Y. Williams) provides just that sound directive influence which is so desirable nowadays, "unless geography," to quote the correspondent in the *Journal* (111 (1948) 296), "is to become a vague unscientific, 'humanistic' study with a strong political and economic flavour." Members of the geological staff contribute to courses in physical geography and economic geography including both lectures and laboratory work; and a senior professor of geology is responsible for the full year's course in geomorphology for graduate and undergraduate geologists and geographers. As elsewhere in Canada and U.S.A., four years are required for a bachelor's degree; and whilst bachelors may proceed to masters' degrees, no doctorates are obtainable at present under the auspices of the department.

In the combined department there is a professorial staff of nine, including one part-time and a visiting professor (from Cambridge); also one lecturer, one instructor and seventeen assistants most of whom are graduate students. But since classes number 200 in some cases (303 is the maximum) the teaching staff in practice is overworked and only a minimum of research can be undertaken during the session; from May to mid-September is, however, the field season habitually reserved for that purpose by the staff.

In November the Geographical Club of the university paid a two-day visit to Seattle, to the State University of Washington. In the Department of Geography there, special lectures and discussions had been arranged and generous hospitality was extended to the visiting party. Amongst other interesting features of a very alive department, was found to be a course newly introduced into the syllabus entitled Mountain Geography in which the writer of this note was called upon to contribute a lecture. It is hoped that a return visit by the University of Washington will later be made to Vancouver. N. E. O.

MAKERERE COLLEGE, EAST AFRICA

The 1948 session witnessed some notable additions to the material equipment of the Department of Geography. At the beginning of the year the map collection of the late Clement Gillman, formerly chief engineer to the Tanganyika railways and a distinguished geographer, was purchased on generous terms from Mrs. Gillman. This material comprises a complete collection of the sheet maps of East Africa published prior to 1946, including the early German maps, and it extends in a fragmentary way to other parts of the African continent and beyond. A welcome gift of surplus G.S.G.S. maps from the War Office must also be recorded with gratitude. A valuable gift from the Director of the

Geological Survey, Uganda, is in the form of carefully selected specimens of the rocks and minerals found within the Uganda Protectorate. A map curator and draughtsman have been appointed to take charge of this and other equipment.

In the main two-year course there were thirty-seven students in the first year, including for the first time some who were taking geography as a subject in the science group; and nineteen students including one woman in the second year. The department is now waiting to implement the terms of the "special relationship" between the college and the University of London as soon as this can be achieved. Under this relationship suitably qualified students of the college will be able to pursue courses leading to the Intermediate and Degree examinations of the University of London.

The first departmental excursion was held during the June vacation when a party of twenty-four students and two members of staff used the Serere Agricultural Station as a centre for field studies in a peninsula flanked by two arms of the drowned valley system of Lake Kioga. There were certain linguistic difficulties in the way of field work, in that all the students happened to be Bantu-speaking whereas the vernacular of Teso belongs to the Half-Hamitic group of languages; but the contrast of the dry savannah country around Serere with the rich terrain in which the college is situated on the northern margins of Lake Victoria provided a valuable geographical experience for all. Perhaps the change of environment most impressed the Baganda students who were obliged in this grain-producing country to forego for a while their staple diet of "matoke."

In the second vacation the department, along with those of English, mathematics and biology, contributed to a fortnight's refresher course for former students of the college now engaged in teaching. From these older men the staff learned a good deal about the educational needs of the East African territories and the vital part which Makerere College must play in meeting those needs.

Research on the trade of Lake Victoria is in progress; and it is planned to make use of the statistical material of the 1948 census of the population of East Africa as it becomes available. The Council of the college has agreed to create a chair of geography. S. J. K. B.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

Since the appointment of Professor E. G. Bowen to the Gregynog Chair of Geography and Anthropology in 1945, it has been the policy of this department, despite its wider official designation, to concentrate on the study of Geography "as that term is understood in the other British universities." The same year saw the appointment of three new members of staff, Mr. A. D. Rees, Mr. C. A. Fisher and Mr. E. Watson, who joined Professor Bowen and Mr. W. Fogg, the sole survivors of the previous régime. Since that time the alarming rise in student numbers (to 127 Subsidiary, 97 Final, 50 Honours and 12 Research in the session 1948–49) has necessitated further increases to the staff, namely, Mr. E. H. Brown, who joined us in 1947, and Mr. J. G. Thomas and Mr. G. M. Howe, both of whom obtained first-class Honours in our own department in 1947 and have now become Assistant Lecturers. The other two "firsts" of their year, Mr. W. L. D. Ravenhill and Mr. W. H. K. Turner, have recently obtained university posts at Exeter and Dundee respectively, and the year before that Mr. R. M. Prothero was appointed to a post in Edinburgh and Dr. Emrys Jones to one at University College, London.

At the present time the Honours syllabus as a whole is characterized by the concentration of courses dealing with the several aspects of geography into the

first and, to a lesser extent, the second years, while most of the regional studies are left until the third year. The importance of practical work continues to be stressed at all levels. It is hoped that next session it may prove possible to introduce some optional specialist courses in the third year in order to give a more specific preliminary training for our rapidly expanding research school. Not unnaturally the latter has a fairly strong local bias; half of our present research students are working on various aspects of the social geography of Wales, while the interests of the remainder range from early Wessex to contemporary Sumatra.

Despite the difficulties of coping with these large numbers in restricted quarters, all members of staff are finding time for at least a modicum of individual work themselves. Professor Bowen continues his researches on the Celtic Saints; Mr. Fogg, Mr. Rees and Mr. Fisher each have either a book or part of a book in preparation, dealing respectively with the Near East, mid-Wales and South-east Asia. Mr. Watson is meanwhile studying the prehistoric settlement of north-east Ireland, Mr. Brown is analysing the geomorphology of Cardiganshire, Mr. Howe is working on the application of air photographs to agricultural geography, and Mr. Thomas on geographical aspects of the Irish border question. Our main difficulty still remains the relative lack of contact with other geography departments, and more visits from geographers would be greatly appreciated by staff and students alike. C. A. F.

THE LE PLAY SOCIETY

The Council of the Le Play Society has arranged an attractive programme for its August excursions. Sir E. John Russell will lead a group going to Sweden, with Rättvik on Lake Siljan, Dalecarlia, as the main centre of the studies to be made. He will have the cooperation of Swedish specialists in farming, industry, etc. Further contacts will be made in Gothenburg where three days will be spent. The expedition will start on August 4 and return on August 24. Dr. Toni Hagen of the University of Zurich is to lead a group of geologists, botanists and human geographers who will have Saas Fee and the Riffelberg (above Zermatt) as their centre of study, from August 9 to 25. Mr. T. C. Nicholas of Trinity College, Cambridge, will be the leader of a geological expedition in Inchnadamph, Assynt, Sutherland. Physical geography and botany will also be studied by a section of the party. The dates for this excursion are August 6 to 20. A group of university students will be led by Mr. S. H. Beaver, University of London, in a field study meeting in France. For full information regarding these and other activities of the Society, application must be made to the Director, Miss Margaret Tatton, The Birlings, Birling Gap, near Eastbourne.

NEW AFRICAN EXHIBITS AT IMPERIAL INSTITUTE

For the first time, visitors to the Imperial Institute, South Kensington, can see something of the everyday lives of the people of East and West Africa. The Institute has always made it possible to study the industries and economies of the Commonwealth and colonial countries through the thousands of photographs, paintings, dioramas and specimens on view in its exhibition galleries. To these have now been added such familiar objects (to Africans) as cooking utensils, samples of foodstuffs, weapons, bangles and other adornments, as well as photographs showing these things in use. Among the new exhibits from West Africa are woven goods and work in wood, leather and silver of traditional design and fine workmanship. The exhibits from East Africa include a series of paintings, executed by an African, showing phases in the education and training of a native who is now an agricultural officer on a government farm.

AMERICAN COMMITTEE ON INTERRELATIONS OF PLEISTOCENE RESEARCH

Dr. Louis L. Ray of the United States Geological Survey informs us that the National Research Council has established a Committee on Interrelations of Pleistocene Research. The Committee, which will attempt to meet a long-felt need, is charged with correlating results of research work in the various fields which are concerned with the Pleistocene. The members are: Edward S. Deevey, Yale University (biogeography); Loren C. Eiseley, Department of Anthropology, University of Pennsylvania (anthropology and new-world archeology); Richard Foster Flint (Department of Geology, Yale University, chairman of the Committee; Claude W. Hibbard, Museum of Paleontology, University of Michigan (vertebrate paleontology); Chauncey D. Holmes, Department of Geology, University of Missouri (glacial erosion and sedimentation); Helmut E. Landsberg, Committee on Geophysical Sciences, Research and Development Board, Washington, D.C. (meteorology and climatology); Hallam L. Movius, Jr., Peabody Museum of Archaeology and Ethnology, Harvard University (old-world archeology); Fred B. Phleger, Jr., Department of Geology, Amherst College (oceanography and sea-floor geology); Louis L. Ray, U.S. Geological Survey, Washington, D.C. (glacial stratigraphy; alpine glacial geology); H. T. U. Smith, Department of Geology, University of Kansas (eolian features; grozen ground; stream terraces); and James Thorp, Division of Soil Survey, U.S. Department of Agriculture, Lincoln, Nebraska (soil science).

Committee members are preparing reports for later publication which will indicate the present status, recent publications, problems and active or anticipated research projects in their various fields of interest. Each member will welcome help and suggestions, including reprints, names of research workers and summaries of investigations being made.

RIDGE AND FURROW AND THE OPEN FIELDS

The origin of the ridge and furrow pattern, or "hills and dales," visible in many Midland fields, has been variously explained. It has for example been attributed to ploughing during the Napoleonic period, or to drainage measures. Mr. M. W. Beresford in a paper reprinted from the *Economic History Review* (2nd ser. 1 (1948) 34–45) offers a simple and far-reaching solution to the problem. He argues that this pattern is the pattern of the strips of the open fields, the ridges having been produced by generations of ploughing the strips in the same direction. The sinuous S-shape of the strips, drawn by the plough, is a characteristic feature, and the strips may be traced independently of the present hedge pattern. He shows that strips were formerly often called ridges, and that the presence of these ridges and furrows was held as evidence that land had previously been arable. From observation on the ground principally in Warwickshire, later supplemented by air photographs, Mr. Beresford has been able to correlate pre-enclosure maps with these features. If his argument is accepted, a strip map can be reconstructed by plotting ridge and furrow on a large scale Ordnance Survey map. Where consistent cross-ploughing may have obliterated ridge and furrow, soil discoloration can often be detected on air photographs.

By this method, it is possible to study the lay-out of open field systems where pre-enclosure maps do not exist, and, carried out extensively, it should throw light on the distribution of this system and other problems connected with it. The average width of ridge and furrow, for example, suggests that the area of a strip was nearer one-third of an acre, and not one acre as some historians have assumed.

CHRISTOPHER SAXTON'S DATE OF BIRTH

From the available documentary evidence, Sir George Fordham concluded that the year of Christopher Saxton's birth was either 1542 or 1544 with a slight preference for the latter ("Christopher Saxton of Dunningley," *Thoresby Soc., Miscellanea*, 9 (1928) 357–94). In 1934 Mr. J. W. Walker in his work on 'Wakefield, its history and people,' p. 319, claimed Saxton as a pupil of Wakefield Grammar School, and in the second edition, 1939, vol. 1, p. 867, inserted the words "born at Wakefield July 28, 1544." To my inquiry as to his authority for this statement, Mr. Walker replied that he had been given it by Mr. M. H. Peacock, headmaster of the Grammar School. The latter had died in 1930, and extensive search and inquiry have failed to produce any direct evidence. Mr. Peacock, on his retirement to Oxford, continued to look for former pupils of his school and sent occasional notes of any Cambridge men to Dr. J. A. Venn for his 'Alumni Cantabrigiensis.' Unfortunately Dr. Venn cannot now trace any letters from him. Yet although unverified, I feel that Peacock, who was a sound classical scholar, would not have made this statement without due authority. I think therefore that it should be put on record for the interest of students of English cartography. It is worth noting that the year agrees with that considered more probable by Fordham.

W. B. CRUMP

WORDSWORTH'S GUIDE TO THE LAKES

The celebrated 'Guide through the District of the Lakes in the North of England' by William Wordsworth has been allowed to lapse for so long that the present generation can have little knowledge of it. The reissue by the Tantivy Press, Malvern, of a facsimile of the fifth and last edition of 1835, at the price of 8*s*. 6*d*., with an introductory note by J. W. Lucas, is therefore most welcome, especially in view of the approaching centenary of the poet's death in April 1950. No guidebook in the ordinary sense, this work has long been regarded as a local geographical classic; and with very good reason for it reveals deep knowledge of the physical structure of the country and of the human responses thereto, besides giving an enlightened comparison of the scenery with that of the Scottish Highlands and the Alps. The scenery is explained in a simple yet scientific manner and its beauty depicted with all the insight and care to be expected of this great interpreter of Lakeland.

The admirable conception that most of the lake basins of Cumberland and Westmorland radiate, like the spokes of a wheel, from the central group of mountains including Scawfell and Great Gable ("Gavel" in the text) emanates from Wordsworth's book, but it has since been followed so mechanically from textbook to textbook as rather to have lost its freshness of appeal. Perhaps a finer generalized picture of the landscape, more effective in helping the reader to revive faded memories, is the poet's threefold division of the area, particularly well illustrated in the case of the largest basin, Windermere, into firstly the swelling foreground of pleasing meadowland, then the picturesque middle zone of rocky hills or hillocks clothed with woods and seamed with torrents, and lastly the imposing background of mountain, fell and moor. The Guide, in fact, is highly skilful in the unified picture which it presents of the Lake Country together with the relationship, upon which so much of its beauty depends, between the sublime elements in the mountain landscape and the gentler features.

The author gives an excellent account of the local climate and weather from the scenic standpoint together with a discussion of the relative merits of the natural colours of the different seasons of the year, voting definitely for winter

over summer. Particularly noteworthy is the description of an ascent of Scawfell Pike one very fine morning early in October 1807 when, after but the slightest hint of change over the Irish Sea, "great masses of cloud came boiling over the mountains" wrapping Skiddaw, Helvellyn and Great Gavel in storm which speedily overtook the Pike with its party.

On the social status of the Lake District and systems of land-tenure in the Dales the author had much to say, and he naturally lamented those changes in building and forestry which even in his day were beginning to disfigure the landscape. But a rugged region like this does not readily yield to outside influence, and even to-day there is much in this Guide which will be found serviceable to residents and tourists for whom it was originally planned. Luckily for the lover of the Lakes, extensive reaches of the fells away from the prescribed routes of modern holiday traffic remain little, if at all, less wild and solitary than they were in Wordsworth's time. There the rambler and hill walker may feel in tune with that stormy mountain wilderness to which the poet himself describes his reactions with so much power in the first and eighth books of 'The Prelude' and elsewhere.

L. C. W. BONACINA

TERRITORIAL REORGANIZATION IN THE INDIAN UNION

Dr. O. H. K. Spate sends us this amendment to his note "A year of change," published in September last year (*Geogr. J.* 111 (1948) 228–92):

By an oversight for which I am responsible the table of the disposition of Indian states on 1 August 1948 is incomplete in one minor respect. This is the omission from the list of states "Merged with Provinces" of Seraikela and Kharsawan which, as shown on the map, have been added to Bihar. The two states together have an area of 603 square miles and a population (1941) of 205,424.

Since the note was published the adhesion of Junagadh to Saurashtra, foreshadowed in it, has taken place; and Orissa has taken over the state of Mayurbhanj (4034 square miles, population 990,977). Small as are the areas involved in these accessions to Bihar and to Orissa, they are not unimportant economically. Kharsawan is one of the leading Indian sources of refractories, Seraikela of asbestos, while Mayurbhanj ranks next to the adjoining Singhbum District of Bihar in the production of iron ore.

TRANSFORMATION METHOD FOR OBLIQUE PROJECTIONS

The popularity of oblique projections has in the past been influenced by the difficulty of their construction. The transformation method set out below allows any oblique projection to be drawn rapidly by a direct transformation.

Consider an equatorial zenithal graticule for one hemisphere drawn on any suitable system: the stereographic or the equidistant. A point x is marked on the circumference in the latitude of the pole of the intended oblique. A tracing of the same equatorial graticule is now placed over it and is rotated until one pole of the tracing lies on the point x. The combination is a projection of one hemisphere of a sphere with two sets of parallels and meridians, a normal set and an oblique set (the tracing). From it can be read off the normal latitude and longitude, from the normal meridian containing the oblique pole x, of the points of intersection of the oblique parallels and meridians. This is what is required for the construction of any oblique graticule with the pole at the latitude of x, be it cylindrical, zenithal, conical or conventional. Transfer these latitudes and longitudes to the equatorial or polar graticule corresponding to the oblique projection required, choosing any desired meridian as the normal meridian containing the oblique pole, and marking two points for each inter-

section, one with the longitude to the west and the other to the east of this meridian. The new graticule is completed by drawing smooth curves through the plotted intersections. PETER HUNT

An equatorial stereographic projection, eighteen inches in diameter and divided to single degrees, which is very suitable for this transformation method, may be obtained from the Society (price 5*s*., to Fellows 4*s*.).

RECENT VOLCANIC ACTIVITY IN NEW ZEALAND

Professor C. A. Cotton, who gave us an account of "The 1945 eruption of Ruapehu" (*Geogr. J.* 107 (1946) 140–3), sends us this note:

In 1946, in the solfataric phase of the eruption of Ruapehu which began the previous year, the crater of the volcano was still floored with lava but pools of water were making their appearance. The former well-known warm crater lake surrounded by glacier ice has now re-established itself, and in May 1948, when Ruapehu was photographed from the air, there were no signs of activity other than wisps of vapour rising from the surface of still water. A week later, however, one of the occasional aftershots of the eruption was reported to have sent up a column of steam 1000 feet high.

The eruption of Ngauruhoe which took place early in 1948 was of the usual kind, ejecting ash and occasionally a few red-hot blocks of lava. Activity was spasmodic and later outbursts were on a minor scale of intensity. In February 1949, however, the volcano entered on a phase of violent eruption, lava rose in the crater and some is reported to have overflowed.

THE SUDAN: A CORRECTION

The Sudan Agent in London has drawn our attention to an error in a recent issue of the *Journal* (111 (1948) 287) where the Anglo-Egyptian Sudan is named in a note headed "University colleges in the colonies." The Anglo-Egyptian Sudan is, of course, under the condominium control of Egypt and Great Britain.

OBITUARY

COMMANDER RUPERT GOULD, R.N.

R. T. Gould was a man of many talents and wide interests. To catalogue his activities is no mean task in itself for he was interested in many things, accomplished in some of them and an expert in one or two. He will perhaps be remembered longest for his monograph on 'The marine chronometer,' in which he not only makes a highly technical subject plain to the ordinary reader but entertains him at the same time. As far as manual dexterity is concerned he must have been the equal of the hero of that book, John Harrison, whose four original chronometers he cleaned and repaired and they can be seen going at the Maritime Museum, Greenwich. In his younger days he was accustomed to write the Lord's Prayer on a threepenny bit, and he usually carried one about with him on which he had engraved it both in Greek and in English. The radio public will probably know him best as a member of the earlier Brains Trust with an encyclopaedic knowledge which used to stagger his colleagues. He was an accomplished raconteur with an endless stock of anecdotes from which he could draw in a flash to illustrate almost any topic of conversation.

His intimate friends knew him also as a man capable of the most intense and prolonged research into the data of geographical history, and he seemed to know by instinct where he would find sources for his writing. This faculty was well shown when he had to reply to Professor Hobbs' allegations as to the accuracy of the Admiralty Records in connection with the first discovery of Graham Land. Several of his books show by their titles his whimsical interest in the odd and the enigmatical, whether fact or theory. He was, for instance, a stout champion of the existence of the Sea Serpent and the Loch Ness Monster and would talk for hours about them. He could discourse equally well on astronomy, navigation, horology and hydrography and was a frequent broadcaster on these and other topics.

In addition to these talents Rupert Gould had a most striking appearance, being tall and, in his youth, quite extraordinarily handsome with a massive head of fair hair and classical features. He was excellent company though one could not compete with him in debate, for he had at his command just ten times the number of facts of an ordinary person. He will be greatly missed in general scientific circles; but it was a wonder he lived as long as he did since he worked and played at twice the rate common to mankind. His recreations as recorded by him in *Who's Who* are as whimsical as his fancies, yet they are true. They are: kite flying; repairing all forms of mechanism; collecting ancient typewriters.

F. D.

Dr. G. B. GRUNDY

Dr. G. B. Grundy, the notable classical geographer, died in Oxford on 6 December 1948, aged eighty-seven. Grundy started teaching at the age of sixteen, and it was not until 1888 that he began his long association with Oxford on entering the university as an undergraduate at the age of twenty-seven. He took degrees in Classical Moderations in 1890 and in *Literae Humaniores* in 1891, and afterwards stayed on with a geographical studentship awarded jointly by the Society and the University. This enabled him to make his first visit to Greece, and his study of 'The topography of the battle of Plataea' was an R.G.S. publication of 1894. After a few years as headmaster of the Oxford Military College, he was for a short time lecturer in ancient history under Professor H. F. Pelham, until his appointment as University Lecturer in Classical Geography, a post which he held for many years. Further extensive travels in Greece were followed in 1902 by the publication of his book on 'The Great Persian War' which is remarkable for the way the major battles are related to the topography of their sites, several of which Grundy had himself surveyed for the first time. Among his many later contributions to ancient history was 'Thucydides and the history of his age,' first published in 1911, which he greatly extended for a new edition just the year before he died. But he was interested in many other subjects, and he will be remembered also for his studies of Roman and Saxon Britain and his researches on place-names and ancient boundaries. His "unconventional autobiography," 'Fifty-five years at Oxford,' which appeared in 1945, reflects the wide range of his interests and his formidable industry which did so much to stimulate the study of classical geography.

CORRESPONDENCE

THE RELATION OF GEOMORPHOLOGY TO GEOGRAPHY

As a Fellow of the Society I beg leave to comment on the letters from Professors Wooldridge and Linton which appear in the *Journal* published in January 1949 (vol. 112, pp. 125–7). I am, in truth, a "nobody" in the congregation of geographers, but nobodies form the majority of most congregations and have a right occasionally to have their say in matters concerning the faith. The sad truth is that members of the Geographical Priesthood have never ceased to wrangle amongst themselves about the Creed. It is long past time that they composed their differences and agreed together on Articles of the Faith.

For myself I am content (as I have reason to believe that most non-academic geographers would be content) to accept the definition once given by Professor Dudley Stamp that "Geography is the study of the World as the home of Man." Such a definition implies that geomorphology has its place in geographical studies just as astronomy, anthropology, climatology, ecology, geology, economics and botany have their places; but such a definition entitles no one to claim absolute priority for any one of these ancillary studies. The geomorphological addict has no more right to claim that his speciality is the core of the subject than has the climatologist or any other specialist. Let them invent such fabulous words as they can think of, they will but make confusion the worse confounded. Geography cannot ever be anything but a composite subject in which many studies must play a part. The genius of the true geographer is to coordinate those several studies into one broad study of the world *as the home of man*, and to make such a study *of service to mankind*. That great object will not be achieved by hurling interdicts from university Chairs or by inventing a jargon with which to veil imagined mysteries.

As many of us see it, the best brains in the subject (or some of them) are too much occupied in defending the exaggerated claims of individually favoured specialities rather than in advancing geographical study generally. Professors of geography are wont to lament the low esteem in which geography is held in the academic world. What else can they expect so long as they cannot agree amongst themselves upon its content or its purpose? The altogether astonishing statement made by Professor Linton that "Geography is not concerned with the study of phenomena in relation to man . . ." must have made several greatly venerated corpses turn uneasily in their graves. If geography is not to be studied in relation to man and (however indirectly) for his benefit then, in Heaven's name, for what is it to be studied? E. O. GIFFARD

2 *February* 1949

Quoting Baulig that "regional geography has no technical vocabulary," Professor Linton asks (*Geogr. J.* 112 (1948) 127) "How else, then, can it describe landforms save in morphological terms?" This question may perhaps be answered by asking another: how can beauty be portrayed save in the language of anatomy, how feelings and emotions save in psychological terms?

Descriptive regional geography, practised as an art, has the wealth of the literary language at its disposal; with this it can depict a landscape vividly enough to give it reality and life. Description restricted to the terms of geo-

morphology and the other contributory sciences may give an exact classification of the various features of a region but it cannot reveal its full "personality." Landforms, no more than human forms, can be brought to life in scientific language; geomorphology is no more cunning in this respect than anthropology or physiology. There is room for art as well as science in geography. Scientific method and language must be used in the study, classification and explanation of the phenomena involved; but their description is an art just as in history narration is an art. Much history is also good literature. If that were so of geography it would stand in higher repute; but it can never become so if it is always to use scientific terminologies and pseudo-scientific jargon.

Professor Wooldridge has lamented the administrator's failure to make good use of geography (*Geogr. J.* 109 (1947) 203). How serious this neglect can be was evident from Mr. E. W. Gilbert's criticisms of the Local Government Boundary Commission's recommendations (*Geogr. J.* 111 (1948) 191–7). Professor Cyril Falls and Field Marshal Lord Montgomery have both stressed the attention that soldiers must pay to geography (*Geogr. J.* 112 (1948) 4–18). How are civil servants, soldiers and others to be persuaded to use geography if it is so terminological that it is unintelligible to them? It would almost seem as if geographers desired to create a bewildered laity, prepared to respect their subject for its mystery and to fee them for its elucidation much as if they were medical or legal practitioners. To write regional geography in "geographical terms" which are part of the language used by all is to leave the door open. To write in geomorphological and other scientific terminology is to close it.

21 *February* 1949 W. H. PARKER

UNDERGROUND WATER STORAGE IN SAND RIVERS

Professor Debenham spoke of the economic development of sand storage in Bechuanaland ("The water resources of Central Africa," *Geogr. J.* 111 (1948) 225). Towards the end of 1946 the writer investigated sand storage in the bed of the Subarnarekha river near Ranchi in Bihar. During the war water had been pumped from these sands for army camps and it was desired to extend the scheme to provide 1,800,000 gallons a day. From observations made during war-time pumping it was ascertained that for nine months of the year river flow would be adequate. Only for three months would sand storage be drawn upon, and even during this period there would be a minimum flow through the sand in excess of 1,200,000 gallons a day. This left 600,000 gallons a day, or a total for 100 days of 60,000,000 gallons to be provided from storage, say, 220 acre feet of water.

On the Ranchi plateau the Subarnarekha river is entrenched in impervious rock, the bed of the river being filled with sand to a depth of from 4 to 10 feet. Outcropping rock bars form a series of basins which may be a mile or more in length. Two of these basins were surveyed and probed to determine the volume of storage available. The sand in the two basins was very uniform with an average void content of 41 per cent. An arbitrary 5 per cent. was allowed for entrapped air, leaving 36 per cent. water content when saturated. Of this, the survey indicated that two-thirds could be recovered.

Evaporation from sand is limited to the water within the depth that can be brought to the surface by capillarity. Samples of sand were tested for capillary rise and averaged 15½ inches. This rise would be reduced by the draw-down due to pumping and a laboratory trial indicated that not more than 75 per cent. of the capillary rise would be effective in supplying water for evaporation—that

is, the surface 12 inches. The annual evaporation from a free water surface in this area amounts to 4–5 feet, most of it occurring during the hot weather before the breaking of the monsoon.

The two basins surveyed had areas of 51 and 67 acres. The total volume of sand was 760 acre feet. The recoverable water was then determined as follows:

	Acre feet
Volume of sand, water and air	760
Evaporation loss, 118 × 1	118
Available sand storage	642
Volume of water, 36 per cent. of available	231
Recoverable water, two-thirds of total	154
Total water storage required for scheme	220
Deficiency	66

It was decided to provide the deficiency from surface storage obtained by building a low concrete weir on the rock bar terminating the smaller basin. This represented 30 days' storage during the hottest period of the year when evaporation would be of the order of ½ inch per day or a total of 15 inches. The required height of the weir was therefore 66/51, say, 1 foot 3 inches. To this must be added a further 1 foot 3 inches for evaporation, making a total of 2 feet 6 inches.

These calculations have been quoted rather fully to indicate that, whereas the storage of water in sand is effective in reducing evaporation loss, in this case from 5 feet per annum to 1 foot, a very considerable volume of sand is necessary. To provide 154 acre feet of water, 760 acre feet of storage covering an area of 118 acres was required. To store the same quantity of water in a reservoir with an average depth of 10 feet of which half would be required for evaporation, would only cover 31 acres and have a volume of 308 acre feet. The recovery of water from a reservoir is also easier and more economical than from sand storage where elaborate pumping plant and collecting galleries are needed. Nevertheless in certain circumstances sand storage is very effective and many camps in India were so served during the war. The main supply, however, comes from the very considerable quantity of water which continues to flow through the sand after all surface flow has ceased.

In conclusion I might state that, due to our departure from India, the proposal to develop sand storage in the Subarnarekha was abandoned.

T. H. F. NEVINS

Wellington, N.Z., 31 *January* 1949

MEETINGS: SESSION 1948–49

First Meeting, 4 October 1948. The President in the Chair

Paper: A new Arabian journey. By Mr. Wilfred Thesiger

Second Meeting, 25 October 1948. Mr. J. M. Wordie, Foreign Secretary, in the Chair

Paper: The Great Ross Barrier of the Antarctic. By Professor Frank Debenham

Third Meeting, 1 November 1948

Films: Innermost Assam. Kodachrome films with commentary by Mrs. F. N. Betts

Fourth Meeting, 8 November 1948. Mr. J. A. Steers in the Chair

Paper: Development areas and the location of industry. By Professor G. H. J. Daysh

Fifth Meeting, 15 November 1948. Mr. E. H. Keeling, Vice-President, in the Chair

Elections to Fellowship: C. A. Ackah, M.A.; Miss Gwynneth Ashby; Martin Harold Austin; Reverend John S. Bain, D.D.; Captain D. B. Baker, R.A.O.C.; Daniel Dias Bandaranayake, B.A.; Norman Baxter; Derek C. Blacker; Cecil Robert Knight Blundell; Miss Myrtle Brixey, B.A.; Leslie George Brown, B.SC.; Professor Harry Oswin Nicholson Bull; Vilas Bunnag; Kenneth G. Burton; Allan John Butler; Thomas Noël Cappie-Wood; Miss Alice Coleman; John Henry Percival Congdon; Robert Cosbie-Ross; Leonard Cutts; Charles George Maurice de Worms, M.A., PH.D.; Miss Patience Anne Empson; P. R. Seymour Eyles; Patrick A. Forte; Lionel John Gilbert; Miss Monica Glyn-Jones, B.A.; John Christopher Willans Goldthorp; Air Commodore G. W. P. Grant, C.B.E.; Vivian Henry Gritton, A.M.I.C.E.; Miss Dorothy Haigh; R. H. Hamblin, M.A.; H. Bruce Henderson; Deryck Mercer Hill; Michael F. W. Holland; Savile Ernest Hudson; Frank Seymour Hulford; Lieut.-Colonel C. F. Hutchinson, D.S.O.; Miss Eileen Mary Teresa Johnson; Commander S. C. Kingsley, R.N. (ret.); W. H. Knott; Alexander McDonald; Thomas A. K. Makumbi; Corporal John Russell Marshall; William Mason; Panna Lal Maulik; Miss Margaret N. Milne; Gordon Frederick Mitchell; David Henry Monro; Herbert Bonamy Morris; Miss Mary G. C. Neeve; Miss Cynthia B. Nunns; James Patrick O'Friel, B.A.; Trevor Reid Pogson; Ivor James Pook; Miss Margaret Powell; David Brine Pritchard; Lieut. Robert Donald Proudlock, R.A.; D. K. Rajakariar; Professor Ramsahae; Gordon de Quetteville Robin; John Hamilton Robson; Captain Wiktor Romanow, M.A.; Kenneth Royston Sealy, B.SC.; Harry Skillington; Miss Annelie Sluzewski; Kenneth William Smith, B.A.; Frank Stafford Snelling; Reverend Charles William Stenson-Stenson; G. D. Stock; Instructor Sub-Lieutenant I D. Storey, R.N.; Charles Winthrop Molesworth Swithinbank; Miss Francis M. Trench; Reverend Edwin Alban Turner; Lieut.-Colonel Arthur Edgar Tydeman; Paul E. Victor; Ronald S. Waters, B.A.; Reginald Gordon Somerville Weston; Neville Reginald Wills, M.SC., B.E.; Edward Geoffrey Wilson; Harry Cuthbert Wise; Miss Helen Elizabeth May Ziegler.

Elections to Associate Membership: Mervyn Bryan Dodd; Trenchard John Fowle; Kenneth Ginger; Miss Sonia Mary Hicks; Miss Elizabeth Langton;

Peter A. Noyle; James Norman Olliver; Miss Dorothy Margaret Page; Miss Ruth Patricia Parfait; Miss Daphne Mary Squires; James Eric Thompson; Donald Frederick Wright.

Paper: New discoveries in British Antarctica. By Captain D. P. Mason

Sixth Meeting, 6 December 1948

Films: The voyage of the raft *Kon-Tiki*. Kodachrome films with commentary by Mr. Thor Heyerdahl

Seventh Meeting, 17 December 1948, following the opening by H.R.H. The Duke of Edinburgh of the exhibition "Navigation through the Ages"

Paper: Radio and position. By Sir Robert Watson-Watt

Eighth Meeting, 20 December 1948. The President in the Chair

Elections to Fellowship: Russell Barnett Aitken; George Ward Brown, B.SC.; Dr. John C. Bugher; Brian William Burton; John Carley; Reverend Arthur Coffey; John H. L. Cooper; Sergeant John Weston Evans; Hussein Fahmy, B.A.; Herbert F. G. Floate; Miss Ella R. Grigg; J. E. H. Grose; Stephen Dennis Harper; Eric Harrison; James Pearson Hewitt; Reverend Thomas H. Kemp, F.PH.S.; Captain Alan Frederick Kettle, T.O.A.R.; Dr. Albert Ernest Lorenzen; Frederick S. A. Mills; Miss Minnie L. Moore, PH.D., B.SC.; Charles Mounsey; Thomas Workman Orr; Robert Wilfred Packer; George Etzel Pearcy, M.A., PH.D.; Captain W. A. Pearson, J.P.; Miss Francis Pilling, B.A.; John Pounds; Gordon B. G. Purnell; Alfred H. Shorter, M.A.; Parbati K. Sircar, M.SC.; Captain H. B. Smith-Cresswell; Whittaker J. Thornley; Reginald Vella Tomlin; Frederick E. O. Tootal, B.A., LL.B.; Mrs. Kathleen M. Tootal; Clive D. J. Trott; Clement T. B. Uren, B.A.; Miss Sheila E. Warwick, B.A. Wilfred Seymour Walker; Frederick Henry Whitehead; Edward K. F. Zarudzki, M.SC.

Elections to Associate Membership: Phillip Frederick Barter; Austen D. Bott; Brian Fullerton; Miss Beryl D. Hammond; Miss Barbara J. Landrey; Michael Alan Morgan; Miss Brenda Williams.

Paper: The navigator's story. By Professor E. G. R. Taylor and Professor W. M. Smart

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